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ORIGINAL ARTICLE

DTI-BR model applied in Foz do Iguaçu, Brazil, for its transformation into a smart tourism destination

Alessandra Bussador[1,*], Bárbara Françoise Cardoso Bauermann[1], Miguel Diogenes Matrakas[2], Janine Carvalho Padilha[3], Kátya Regina de Freitas Zara[3]

[1] *Institute of Applied Technology and Innovation, ITAI, Av. Tancredo Neves 6731, Foz do Iguaçu, Parana, Brazil*

[2] *Itaipu Technological Park, PTI, Av. Tancredo Neves 6731, Foz do Iguaçu, Parana, Brazil*

[3] *Federal University of Latin American Integration, UNILA, Av. Tarquínio Joslin dos Santos 1000, Foz do Iguaçu, Parana, Brazil*

ABSTRACT

With the increasing concentration of people and services in urban centers, there is a growing prevalence of issues related to mobility, accessibility, housing, access to urban infrastructure, safety, leisure, tourism, sanitation, and sustainability. In response to the need for sustainability, these urban centers integrate information and communication technologies to optimize and assist in decision-making for public service management. As smart cities integrate the social, physical, and digital systems, they enable a participatory model of government management. Touristic cities, which include smart city indicators and integrate sustainability and technology throughout the tourism value chain, create sustainable development based on local limitations and capacities while enhancing the integration of technology throughout the tourism destination's value proposition. Thus, this paper aims to analyze the municipality of Foz do Iguaçu as a smart tourism destination by applying the DTI-BR model. As a result, the application of the DTI-BR model in Foz do Iguaçu showed evidence that the municipality needs to improve its indicators to be considered a smart tourism destination, which implies the need for improvements in public-private partnerships for the municipality's development as a smart city.

KEYWORDS

smart city; smart destination; intelligence indicators; public policies; ISO standards

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*CORRESPONDING AUTHOR
Alessandra Bussador, Institute of Applied Technology and Innovation, ITAI, Av. Tancredo Neves 6713, Foz do Iguaçu, Parana, Brazil; alessandra.bussador@itai.org.br

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1. Introduction

The Brazilian Ministry of Tourism defines a smart tourism destination (SD) as an innovative and accessible tourism space, built on cutting-edge technological infrastructure that ensures sustainable development and facilitates interaction and integration of visitors with the environment, enhancing

the quality of their tourism experience in the destination. This concept was developed by the State Mercantile Society for the Management of Innovation and Tourism Technologies (SEGITTUR) in Spain in 2013 and adapted by the Argentine Institute of Cities of the Future (Ministry of Tourism, 2021; SEGITTUR, 2021).

SDs are characterized by the pillars that govern tourism management: governance, innovation, sustainability, technology, and accessibility. Smart cities and smart destinations have synergies because they share the same goal: improving the quality of life for citizens (Guerrero and Acosta, 2019).

The use of information and communication technologies (ICT) in SDs enhances the tourist experience. Therefore, SDs are, above all, smart cities (SCs) that enable sustainable tourism development. These cities cater to visitors in a way that resembles meeting the needs of their residents, in terms of supporting mobility, allocating resources, and enhancing sustainability and quality of life (Herscovici et al., 2022).

Grimaldi and Fernandez (2017), Kraus et al. (2015), and dos Santos and Gândara (2016) state that smart cities have provided differentiated experiences to their residents through the available technological infrastructure, thereby contributing to the improvement of quality of life and sustainable economic growth. They consider a participatory model of government management to drive local economic development.

The use of indicators assists in public administration to improve the efficiency of public services provided to the population. It allows for the evaluation of smart cities by assessing the presence of smart technologies and their integration with existing infrastructure, while considering the cost-benefit relationship. Indicators can contribute to city comparisons, support integrated policies and decision-making, and monitor performance (Ivars-Baidal et al., 2021, dos Santos and Gândara, 2016).

The reference for cities in Brazil includes the family of standards from the Brazilian Association of Technical Standards (ABNT) NBR ISO 37120:2021. They follow the principles set out in ISO 37101 (Sustainable development in communities—Management system for sustainable development—Requirements with guidance for use) and can be used in conjunction with ISO 37101 and other strategic frameworks. These standards define and establish methodologies for a set of indicators related to sustainable development, with the aim of guiding and measuring the performance of urban services and quality of life (ABNT, 2021). In this context, tourist cities, which include indicators of smart cities, integrate sustainability and technology throughout the tourism value chain as a strategy. They create sustainable development based on local limitations and capacities and enhance the integration of technology in the entire value relationship of the tourism destination.

Considering that Brazil is investing in the construction of smart cities, many of which have a tourism characteristic, Bussador et al. (2022) recognized the importance of examining the relationship between the international indicators of SEGITTUR on smart tourism destinations (SDs) and the ABNT standards related to sustainable cities and communities for the transformation of these cities into smart tourism destinations. They proposed the DTI-BR model by adapting these indicators to Brazilian tourist cities.

In this context, the objective of this study was to analyze the municipality of Foz do Iguaçu as a tourist city with the potential to be transformed into a smart tourism destination by applying the DTI-BR model. The application of the DTI-BR model involved four stages: evaluation questionnaires, hierarchical decision tree creation, qualification of indicators, and comparison with priority levels.

2. Brief approach of smart tourism destination

The convergence of ICTs with the tourism industry has prompted a quest for new approaches to destination planning and management. This search has led to the emergence of SDs, which are closely linked to the growing number of smart city initiatives and the concept of "smart tourism". Smart destinations are characterized by their focus on leveraging ICTs and innovative solutions to enhance competitiveness, sustainability, and the overall visitor experience. They aim to integrate technology, data, and connectivity to create more efficient and intelligent destination ecosystems. By adopting smart technologies and strategies, destinations can optimize their resources, improve infrastructure and services, and offer personalized experiences to visitors. This includes utilizing mobile applications, big data analytics, the Internet of Things (IoT), artificial intelligence (AI), virtual and augmented reality (VR/AR), and blockchain, among other cutting-edge technologies (Sigala, 2018; Soares et al., 2022).

With technology integrated into all organizations and entities, tourism destinations leverage the synergies between technology and their social components to enhance experiences. By applying the concept of intelligence to meet travelers' needs before, during, and after their trip, destinations can increase their level of competitiveness. This is one of the main challenges for urban tourism management (Herscovici et al., 2022).

Jovicic (2019) defines, in his study, three concepts of tourism destination that significantly contributed to the development of theoretical thinking in tourism and reflected in the evolution of destinations in practice: the classical-traditional vision, the systemic approach to tourism destinations, and the concept of SDs (**Table 1**).

Table 1. Evolution of tourism destination concepts.

Type of approach	Approach		Smart tourism destinations
	Classical	Systemic	
Definition	It focuses on the importance of geographical characteristics for the occurrence and development of destinations.	It is caused by the dynamic development of tourism practice and significant improvement in tourism theory.	They represent complex systems in which the digital revolution enables better collaboration between tourism companies and tourists, who share information and knowledge.
Characteristics	• Clusters of attractions and services. • Lack of cooperation within the destination. • The role of tourists as actors in the destination.	• Interaction among tourists, service-providing companies, and destination residents. • Continuous contact with the macro-environment. • Non-linear connections among stakeholders.	• Integration of digital and physical tourism. • Public-private collaboration of consumers. • Participatory governance. • Creative and knowledgeable people. • Co-creation of destination value. • Personalized services.

Source: Adapted from Jovicic (2019).

Smart tourism destinations make intensive use of information and communication technologies to enhance the tourist experience. Therefore, smart tourism destination are, first and foremost, smart cities that enable sustainable tourism development while maintaining the quality of life for residents. These cities cater to visitors in a manner that resembles meeting the needs of their residents, in terms of supporting mobility, allocating resources, and enhancing sustainability and quality of life (Herscovici et al., 2022).

The concept of smart tourism destination, created by the *Sociedad Mercantil Estatal para la Gestión de la Innovación y las Tecnologías Turísticas* (SEGITTUR) in Spain, has been adopted as a conceptual foundation and strategic tool aimed at creating tourism experiences and enhancing destination management through knowledge (SEGITTUR, 2021). The conceptualization of SDs was defined in 2012 as follows:

> An innovative tourist space, accessible to all, built upon cutting-edge technological infrastructure that ensures the sustainable development of the territory, facilitating the interaction and integration of visitors with the surroundings, and enhancing the quality of their experience in the destination as well as the quality of life for residents (SEGITTUR, 2021).

The concept of SDs, created by the SEGITTUR and published by the Spanish Association for Standardization (UNE), has been adopted as a conceptual framework and strategic tool aimed at creating tourism experiences and enhancing destination management through knowledge. The standards that present indicators for SDs are UNE 178501 for the Management System of a Smart Tourist Destination, UNE 178502 for Indicators and Tools of the Smart Tourist Destination, and UNE 178503 for Semantics applied to Smart Destinations.

The Spanish community has transformed its tourism management, aiming to enhance the quality and sustainability of its destinations and provide unique tourism experiences. These actions have been based on the use of ICT to increase competitiveness. The main objective of the SD concept is to provide real-time services to tourists, interacting with them and other stakeholders to create an environment of cooperation and data sharing, information, and knowledge for innovation generation (Muniz et al., 2020).

Based on research and SC methodologies, it is evident that a SD successfully implements intelligence fostered by open innovation, supported by investments in human and social capital, and sustained by participatory governance. These characteristics enhance the collective competitiveness of tourism destinations to improve social and economic prosperity, as well as environmental sustainability for all stakeholders, creating an ideal habitat for the smart tourism destination (Boes et al., 2016).

dos Santos and Gândara (2016) define a SD as a tourist territory that has a defined project and objective, with the ability to create sustainable development based on local limitations and capacities. It enhances the integration of technology throughout the value-creation relationship of the destination and reinforces and incorporates actions between public and private managers to promote greater destination competitiveness. According to Gretzel et al. (2015), the term “smart” is the new buzzword in tourism that describes and integrates concepts of technology, economy, and social development fueled by information and communication technologies, promoting connectivity and information exchange.

By applying the concept of intelligence to meet travelers' needs from planning to post-trip, tourism destinations can increase their level of competitiveness. The five pillars of intelligence applied to SDs are governance, innovation, technology, human capital, and social capital.

According to Buhalis and Amaranggana (2014), the concept of SDs emerged from the development of SC characteristics, and they present in their study the aspects of smart indicators in a city. With the use of technology in all organizations and entities, destinations leverage the synergies between ubiquitous technology and its social components to support the enhancement of tourist experiences. These smart indicators in a SC are defined as:

- Smart governance: related to the aspect of transparency within governance systems through the modernization of city administration, supporting data openness and public involvement.
- Smart environment: related to energy optimization that leads to sustainable management of available resources.
- Smart mobility: refers to accessibility within and outside the city and the availability of modern transportation systems.
- Smart economy: related to the implementation of economic strategies based on digital technology.
- Smart people: corresponds to the level of qualification of the city's human capital.
- Smart life: involves the quality of life measured in terms of a healthy environment, social cohesion, tourist attraction, and the availability of cultural and educational services.

The connection between tourists and tourism destinations can be facilitated through various types of technological resources. Real-time collection of information through sensors distributed throughout the city, along with their processing, can provide accurate city information through end-user devices. This reflects the use of ICT as a predictive tool to implement a smarter way of managing tourism destinations (Buhalis and Amaranggana, 2014).

In terms of national actions, in 2022, Brazil introduced a public policy for SDs, developed by the Ministry of Tourism (MTur) in partnership with the Institute *Ciudades del Futuro* from Argentina. The Brazilian methodology is an adaptation of SEGITTUR, with adjustments to the specific characteristics found in Brazil, starting with its territorial size. It is based on nine pillars that serve to organize the requirements applicable to a SD, which are: Governance; Innovation; Technology; Accessibility; Creativity; Sustainability; Safety; Mobility and Transportation; and Promotion and Marketing (Ministry of Tourism, 2022).

This methodology also incorporated normative references such as ABNT NBR ISO 9000:2015 (Quality Management Systems—Fundamentals and Vocabulary), NBR ISO 9001:2015 (Quality Management Systems—Requirements), UNE 178.501 (Tourism Destination Management System), and UNE 178.502 (Indicators and Tools for Smart Tourism Destinations) (Ministry of Tourism, 2022).

Following the same theme, Bussador et al. (2022) based their SD model (DTI-BR model) on a set of indicators from the ABNT standards for Sustainable Cities and Communities, as well as smart tourism destination indicators defined by SEGITTUR. They created a decision tree using the Analytic Hierarchy Process (AHP), a multicriteria method, to evaluate these indicators. The objective of the DTI-BR model is to quantify the level of compliance with SDs for each criterion, sub-criterion, and indicator presented in the model.

3. Methodology

The construction of the DTI-BR model (smart tourist destination—Brazil) involves several stages and important considerations, including:

- Defining objectives: the first step was to clearly establish the objectives of the DTI-BR model, with the aim of identifying the purpose of the model, the target audience, and the key areas of evaluation related to a smart tourist destination.
- Identifying criteria: based on the defined objectives, key criteria were identified to evaluate the degree of compliance of municipalities. These criteria covered areas such as environment, mobility, economy, governance, quality of life, and people.
- Defining subcriteria and indicators: for each identified criterion, specific subcriteria and indicators were established to provide data and metrics for the evaluation of municipalities. The subcriteria helped break down the criteria into more detailed components, and the indicators are quantitative and qualitative measures used to assess performance in each subcriterion.
- Collecting data: it was necessary to identify relevant data sources for each indicator, which in this case involved government agencies. A data collection plan was established to ensure that the necessary information was obtained appropriately.
- Weighting and scoring: defining a scoring scale (in this case, the Saaty scale [1977]) and weighting the indicators were important steps to assign values to the collected data. This allowed for comparison among different evaluated entities and obtaining an overall score for smart tourist destinations.
- Testing and validation: before being widely used, the DTI-BR model was tested and validated to ensure its reliability and effectiveness. The model was applied in Foz do Iguaçu (Brazil), feedback was obtained from experts, and iterative revisions were made for continuous improvement.
- Implementation and monitoring: the DTI-BR model can be used as a diagnostic and guidance tool to effectively drive the transformation of a municipality into a smart tourism destination. It provides a framework for implementing the necessary strategies and initiatives and allows for continuous monitoring of progress and performance.

It is important to emphasize that the DTI-BR model is subject to adjustments and improvements as the understanding of smart tourism destinations evolves and new needs emerge.

The DTI-BR model was applied to evaluate Foz do Iguaçu city, Paraná, Brazil. In the creation of the DTI-BR model, the six smart indicators from Buhalis and Amaranggana (2014) were used as criteria, and for the sub-criteria, a comparative study of SD topics from SEGITTUR (UNE 178501 for the Management System of a Smart Tourist Destination, UNE 178502 for Indicators and Tools of the Smart Tourist Destination, and UNE 178503 for Semantics applied to Smart Destinations) and the ABNT ISO 37120:2021 family of standards, which define indicators for Smart and Resilient Cities, was conducted. Once this relationship was established, a set of indicators from SEGITTUR's

SD indicators, as well as the NBR ISO 37122:2020 (it is an identical adoption, in technical content, structure, and wording, of ISO 37122:2019, which was developed by the Technical Committee Sustainable Cities and Communities (ISO/TC 268)) and NBR ISO 37123:2021 (it is an identical adoption, in technical content, structure, and wording, of ISO/IEC 37123:2019, which was developed by the Technical Committee Sustainable Cities and Communities (ISO/TC 268), in accordance with ISO/IEC Guide 21–1:2005) standards were adopted as the indicators for the DTI-BR model. This relationship of standards is presented in **Table 2**.

Table 2. Criteria and subcriteria for the application of the DTI-BR model.

Criteria	Subcriteria	SEGITTUR	ABNT ISO 37122:2020	ABNT ISO 37123:2021	DTI-BR Indicators
Smart sustainable environment	Sustainability	10	11	5	16
Smart mobility	Telecommunications and Sensing	5	3	0	7
	Transportation and Accessibility	5	12	1	17
Smart economy	Economy and Finance	2	4	3	9
	Online Marketing	8	0	0	8
	Smart Tourism	16	1	0	16
Smart governance	Governance	11	0	1	9
	Urban Planning	0	16	1	14
Smart quality of life	Information Systems	8	0	0	8
	Public and Social Services	0	10	4	13
Smart people	Innovation	6	0	0	6
	Population and Education	1	8	2	11
Total		72	65	17	134

The set of 134 indicators in the DTI-BR model consists of 53.7% of indicators from SEGITTUR's definition of smart tourism destinations, 48.5% of indicators from the Brazilian standard for smart cities, and 12.7% from the Brazilian standard for Resilient Cities.

The DTI-BR model was created by Bussador (2023)[1] and involves a set of indicators from Brazilian standards for smart and resilient cities, as well as smart tourist destinations defined by SEGITTUR (**Table 2**), which must be met by the destination. **Figure 1** presents the hierarchical decision tree generated by the DTI-BR model, illustrating the distribution of criteria and subcriteria.

The application of the DTI-BR model is carried out in four stages. In stages 1 and 2, the evaluation questionnaires are applied: Questionnaire 01 (analysis of criteria and subcriteria) and Questionnaire 02 (analysis of indicators) (see Bussador, 2023). In stage 3, the hierarchical decision tree is created with the priority percentages from Questionnaire 01 using the AHP method. Stage 4 qualifies the DTI-BR indicators based on the information from Questionnaire 02 and compares them with the priority level generated by the decision tree. With these results, the degree of compliance

[1] The research that led to the creation of this model was Bussador's doctoral thesis (2023).

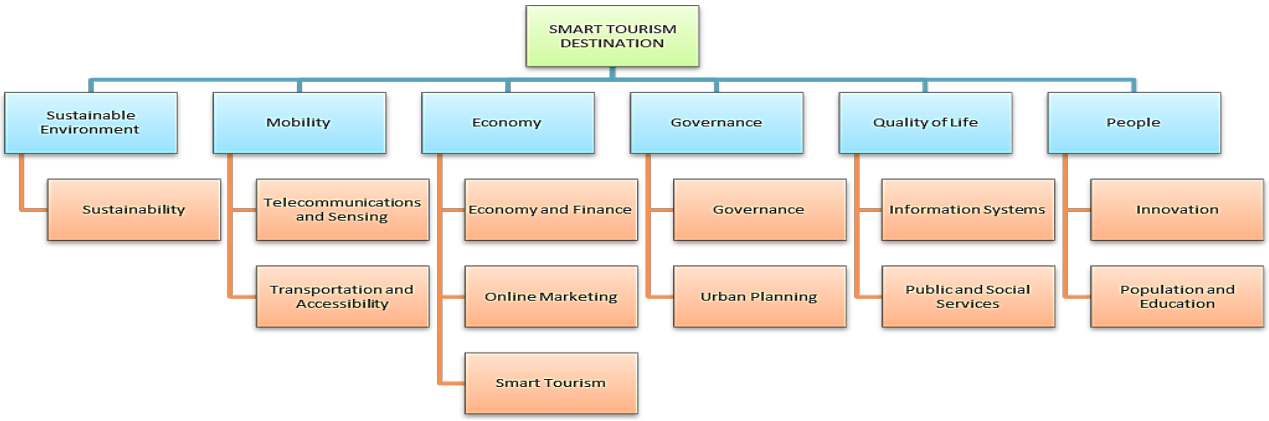

Figure 1. Decision tree of the DTI-BR model.

of these indicators is calculated, considering the percentage of "Medium" and "High" responses that account for more than 50% of the responses per indicator.

For this research, stages 1 and 2 consisted of the application of two questionnaires, which occurred concurrently with the data collection from the municipality. These questionnaires do not necessarily need to be applied to the same individuals; however, both were intended for experts working in the municipal public administration.

Questionnaire 01 assessed pairwise the importance of each item (criteria and sub-criteria) relative to one another. With this evaluation, the AHP (Analytic Hierarchy Process) method was used to create the hierarchical decision tree (step 3) for a group of decision-makers with the priority percentages of the criteria and sub-criteria. Questionnaire 02 quantified the indicators of the DTI-BR model generating information about the municipality.

Based on the evaluations from Questionnaire 01, a hierarchical decision tree was created, with the percentage priorities assigned to criteria and sub-criteria (stage 3). For this purpose, the AHP method was used.

In stage 4, the results from the decision tree and the degree of compliance obtained from Questionnaire 02 are compared, resulting in a quantitative and qualitative analysis. This analysis highlights the indicators that are met or not by public policies and municipal actions. With the generation of the decision tree and the degree of compliance, a comparative analysis is conducted, which serves as a subsidy to identify how municipal resources are allocated based on the priorities defined in the decision tree, even if the degree of compliance suggests a different order of priority. The analysis can be revisited after each change of government or following the implementation of public policies aimed at SD development to reassess priorities and the degree of compliance.

It is important to emphasize that the DTI-BR model was a proprietary project developed in two stages: (i) literature review, and (ii) model construction and application with discussion of the results. Stage 1 involved activities such as literature review to characterize Smart cities and smart tourism destinations, as well as multicriteria analysis followed by documentary analysis of ABNT standards to support the development of the data collection instrument for the indicators. Stage 2 was divided into indicator analysis and selection, and evaluation and revision. In this stage, indicators that best suited the characteristics of Brazilian DTIs were chosen, and the decision tree

was created. **Figure 2** summarizes the process of model construction.

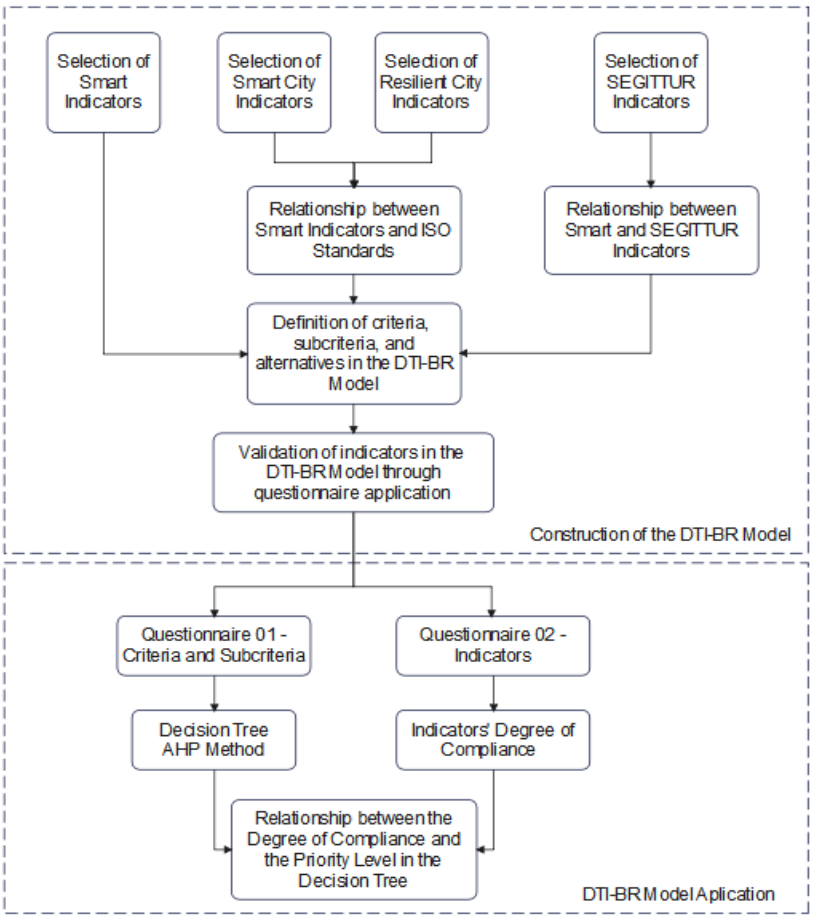

Figure 2. Process of DTI-BR model construction.

Each of these phases presented in the **Figure 2** corresponds to specific and interconnected activities for the construction of the decision tree and evaluation of the compliance level with the DTI indicators.

In this research, the case study was conducted in Foz do Iguaçu, Paraná, which has the following characteristics:

- It is a medium-sized city by Brazilian standards.
- In 2022, it ranked 10th in the connected smart cities ranking for the South region of Brazil. This ranking collects data and information from all Brazilian municipalities with over 50,000 inhabitants (Urban Systems, 2022).
- By the end of 2022, it did not have a tourism plan specifically focused on SDs, nor did it have public policies that included indicators in the context of SDs.

Thus, the DTI-BR model was applied in a case study in Foz do Iguaçu, Paraná, Brazil, generating a comparison between the hierarchy generated by the decision tree and the compliance level of the destination's indicators.

Initially, Questionnaire 01 was applied to the general population, obtaining 128 responses. However, after applying the AHP method, an inconsistency index above the acceptable level was

observed. It was noticed that the community could not be the population of this research, and their responses were discarded. Therefore, it was decided to apply Questionnaire 01 only to experts.

Therefore, the sample for Questionnaire 01 consisted of 10 departments of the Foz do Iguaçu City Hall (Health, Education, Commercial, Industrial and Agricultural Development, Transparency and Governance, Environment, Planning and Resource Mobilization, Sports and Recreation, Public Security, Information Technology, and Tourism and Strategic Projects). Therefore, two individuals from each department were interviewed, resulting in a total sample size of 20 people.

On the other hand, the sample for Questionnaire 02 consisted of three technical professionals from the Tourism and Strategic Projects, Planning and Resource Mobilization, and Information Technology departments. The selection assumed that these departments hold the key information about the existing resources in the city, thus constituting an intentional sample to quantify the indicators of the DTI-BR model.

The inclusion criteria for the sample were individuals of both genders, over 18 years old, who are experts in the research areas of interest, have signed the informed consent form, have knowledge in computer science, and work in public administration.

Both Questionnaire 01 and Questionnaire 02 were administered using the online tool Google Forms. The first questionnaire was designed for the representative experts of the city to assess the degree of importance of SD characteristics. The second questionnaire aimed to quantify the aspects proposed by the indicators of the NBR ISO and SEGITTUR standards, evaluating the existing resources in the city.

For data validation, the AHP (Analytic Hierarchy Process) method was used. This method provides a comprehensive and rational procedure for modeling a decision problem, representing and quantifying the variables involved in a hierarchy of criteria weighted by preferences (weights). The result is a model that allows for the analysis of multiple alternatives and facilitates quick comparisons (Saaty, 1977).

To determine the quantitative coefficients of significance for criteria and subcriteria and create the decision tree, Questionnaire 01 was used, which employed a scale of importance based on Saaty's Fundamental Scale (**Table 3**).

Table 3. Evaluation scale.

Degree of importance	Description
1	Same importance
2	Slightly more important than the other alternative
3	Significantly or essentially more important
4	Very significantly or strongly demonstrated importance
5	Absolutely more important

Source: Adapted from Saaty (1987).

In Questionnaire 02, the most relevant alternatives for each of the subcriteria are defined, and individual measurement of each alternative was carried out by the experts.

By conducting the research, the data collection provided insights into the reality of Foz do Iguaçu. The administration of questionnaires allowed for the selection of more appropriate indicators of smart and resilient cities applied to a SD, as the criteria and subcriteria were evaluated pairwise according to their importance. The weighting of criteria and subcriteria demonstrated which evaluated aspects are of greater importance to the group of decision-makers.

It is important to highlight that this methodology is specific to the Brazilian context as it considers Brazilian standards for the analysis of indicators and SD categories. However, it can be replicated in any country by adopting the local legislation on smart tourism destination.

4. Findings

The results of this study were obtained through the application of the DTI-BR model and the quantitative and qualitative analysis of the indicators that were met or not by municipal public policies. The decision tree generated from the application of stage 1 is presented in **Figure 3**.

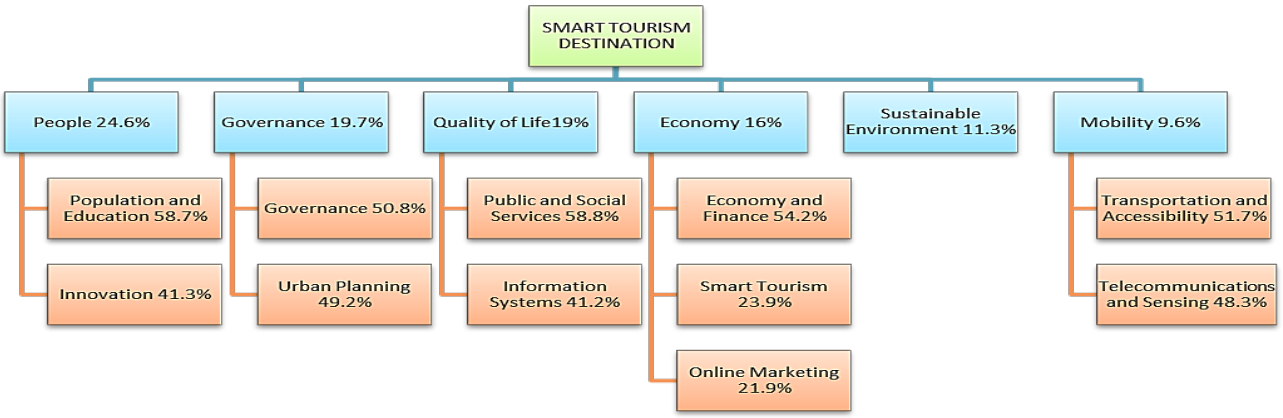

Figure 3. Hierarchical decision tree.

Although Foz do Iguaçu is implementing plans and programs to become a SD, the local population was prioritized in the evaluation by the experts, as indicated by the decision tree (**Figure 3**).

Table 4 presents the comparison of the decision tree percentages and the degree of compliance with the indicators for the municipality, ranked by priority, as well as the compliance percentages of the subcriteria for Foz do Iguaçu.

5. Discussion

The application of the DTI-BR model indicated that “People” is the second highest in terms of compliance, with 41.2% of its indicators being met by the municipality. However, the criterion “People” is the priority for Foz do Iguaçu, with an indication of 24.6%. This criterion is related to the level of qualification offered to citizens and their quality of life, as well as their participation in public life in the municipality. Within this criterion, “Population and Education” (58.7%) was prioritized over “Innovation” (41.3%). In fact, innovation comes through education.

Table 4. Degree of compliance of criteria and subcriteria.

Criteria	Weight in the decision tree	Degree of compliance with the criterion	Subcriteria	Degree of fulfillment of the subcriteria
People	24.6%	41.2%	Population and Education	36.4%
			Innovation	50.0%
Governance	19.7%	17.4%	Urban Planning	7.1%
			Governance	33.3%
Quality of life	19.0%	40.9%	Information Systems	25.0%
			Public and Social Services	53.0%
Economy	16.0%	63.6%	Economy and Finance	55.6%
			Smart Tourism	56.2%
			Online Marketing	87.5%
Sustainable environment	11.3%	18.7%	Sustainability	18.7%
Mobility	9.6%	33.3%	Transportation and Accessibility	17.7%
			Telecommunications and Sensing	71.4%

Indeed, for a destination to be smart, its population needs to be smart. It is impossible for a destination to become smart without considering the people who inhabit it, as they are the ones who promote entrepreneurship and tourism activities, as well as the interaction between tourists and the local community. In addition, it is important for a smart tourism destination to have citizens with knowledge of other languages, as the educational level of the population tends to benefit the development of innovative projects. These projects are often carried out in collaboration with national and international universities and research institutions.

"Governance" was considered the second criterion in the hierarchical order of priority for the municipality, with a priority indication of 19.7%. "Governance" as a criterion is related to the efficiency of public services provided and the existence of channels for transparency of the municipality's actions. Within this criterion, "Governance" (50.8%) takes priority over "Urban Planning" (49.2%).

"Governance" in SDs is focused on the development and implementation of annual operational plans for smart tourism and strategic tourism, which should be included within the urban planning of the city. Considering these actions aimed at smart tourism, urban planning should consider the population density of the area and the percentage of areas covered by threat maps.

The third priority criterion is "Quality of Life", with an indication of 19.0%. This criterion corresponds to the management of health, public safety, housing conditions, as well as the level of quality of life for citizens. Within this criterion, "Public and Social Services" (58.8%) take priority over "Information Systems" (41.2%).

In terms of "Quality of Life", it is observed that information systems are important for improving public services, but they should not be more important than the service provided to citizens and tourists. Information systems can assist in real-time threat alert systems, appointment scheduling,

remote assistance, as well as support the population and businesses with smart water and energy meters.

"Economy" was identified as the fourth most important criterion, with a priority indication of 16.0%. "Economy" focuses on productivity, entrepreneurship, innovation, and the labor market. Within this criterion, "Economy and Finance" (54.2%) take priority over "Smart Tourism" (23.9%) and "Online Marketing" (21.9%).

The criterion "Economy" highlights that expenses related to emergency management planning and the allocation of reserve funds for disasters are more important for a smart tourism destination than analyzing tourist demand, for example. It is necessary to have a good survival rate for new businesses and availability of open data to have better conditions for analyzing tourist demand and the level of tourist satisfaction, as well as analyzing the evolution of accommodation occupancy rates and the level of trust among entrepreneurs. The development of online marketing for the smart tourism destination is also important but not as crucial as the factors mentioned above, as online marketing focuses on sales through the destination's website and monitoring the brand of the smart tourism destination.

"Sustainable Environment", which encompasses sustainability, was indicated as the fifth criterion with a priority of 11.3%. This criterion relates to environmental issues, water and energy, and sustainable management. Since it has only one subcriterion ("Sustainability"), it is not presented in the hierarchical decision tree (**Figure 3**). However, it is important to analyze the evaluation of indicators within this subcriterion, which met 18.7% of the requirements.

"Sustainable Environment" criterion encompasses the analysis of specific plans for the development of sustainable tourism, focusing on the sustainability of the destination. This includes the implementation of waste collection and treatment programs, including recycling and composting, as well as awareness campaigns targeting the local population and tourists.

Finally, the last criterion in the priority ranking is "Mobility", with a priority indication of 9.6%. This criterion relates to transportation initiatives, transportation safety, the use of non-polluting vehicles, and population access to the Internet. It was observed that "Transportation and Accessibility" (51.7%) have priority over "Telecommunications and Sensing" (48.3%).

In terms of "Mobility", the existence of public transportation and information services adapted to the needs of people with disabilities, transportation powered by clean energy systems, and evacuation routes were considered more important than access to free broadband provided by the smart tourism destination to the population and the availability and quality of Wi-Fi in tourist spots.

It was observed that Foz do Iguaçu still needs to improve its SD indicators to be considered a smart tourist destination, as only the Economy criterion fulfills more than 50% of the indicators. This implies the need for improvements in public-private partnerships for the development of the municipality as a smart destination. Given this, it is worth noting that the identification of these indicators in the tourism destination can help improve the planning and management of the tourism activity, enabling its transformation into a smart tourist destination.

Therefore, despite the degree of fulfillment of the indicators suggesting a different order than that of the hierarchical tree, the municipality should act according to the order of criteria generated by

the hierarchical tree, as it identifies the priorities of the municipality as determined by the experts.

6. Conclusion

With the results of the priority level obtained from the decision tree and the fulfillment degree of the DTI-BR model, a comparative analysis was conducted to provide insight into how municipal resources are allocated. Depending on the experts' responses, the fulfillment degree results may recommend a different prioritization order than the decision tree results, as identified in this case study. Although the fulfillment degree of the indicators suggests a different order than the decision tree, the municipality should act according to the criteria order generated by the decision tree, as it represents the priorities identified by the experts in the municipality.

For instance, it was observed that the "Governance" criterion ranks second in priority for the municipality, but it has the lowest fulfillment degree percentage (17.4%). On the other hand, the "Economy" criterion achieved the highest fulfillment degree (63.6%), with its subcriteria having more than 50% of their respective indicators fulfilled. However, it ranks fourth in priority in the decision tree.

The analysis can be conducted again after each change of government or following the implementation of public policy actions designed for the development of SDs, in order to reassess priorities and fulfillment levels, thereby adjusting the focus of public and private investments to meet the indicators. This allows for the review and adaptation of strategies and resource allocation to effectively address the priorities and requirements of a smart and sustainable destination.

The practical contributions of this research can help in the transformation of Brazilian tourist destinations into SDs by adapting international indicators to the Brazilian reality. From a social perspective, the prioritization of indicators resulting from the application of the DTI-BR model in the tourism destination contributes to the decision-making process and management of sustainable tourism activities, enabling its transformation into a SD.

It is also worth mentioning the limited knowledge dissemination of smart cities and smart tourism destinations among the staff of the Foz do Iguaçu municipality. This has resulted in a small number of experts available to respond to the questionnaires in this research, particularly in Questionnaire 02, which had only three respondents (one from each department involved in the SD theme).

Ethics statement

The study was submitted to the Brazilian Research Ethics Committee under protocol IACUC number 51906921.0.0000.8527.

Author contributions

Conceptualization, AB and BFCB; methodology, AB, BFCB and MDM; software, MDM; validation, AB, BFCB and MDM; formal analysis, AB and BFCB; investigation, AB; resources, AB; data curation, AB, BFCB and MDM; writing—original draft preparation, AB and BFCB; writing—review and editing, AB, BFCB, MDM, JCP and KRFZ; visualization, AB, BFCB, MDM, JCP and

KRFZ; supervision, AB, BFCB, MDM, JCP and KRFZ; project administration, AB, BFCB, MDM, JCP and KRFZ. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

No conflict of interest was reported by all authors.

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