

SMART TOURISM AND THE DIGITALIZATION OF THE TOURISTIC EXPERIENCE: THE CASE OF NOVA PETRÓPOLIS/RS

O TURISMO INTELIGENTE E A DIGITALIZAÇÃO DA EXPERIÊNCIA TURÍSTICA: O CASO
DE NOVA PETRÓPOLIS/RS

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CASO DE NOVA PETRÓPOLIS/RS

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ABSTRACT:

Purpose – This article analyzes the productive structure of the municipality of Nova Petrópolis (RS) from the perspective of Research and Innovation Strategies for Smart Specialization (RIS3), suggesting guidelines for digital transition and improving the consumer journey in tourism.

Design/methodology/approach – The quantitative-qualitative, analytical, propositional approach uses longitudinal secondary data on jobs and establishments (2020–2024) extracted from the Ministry of Labor and Employment (MTE), which were analyzed using the calculation of the Location Quotient (LQ) and the Herfindahl-Hirschman Index (HHI).

Findings – The results point to an economy concentrated in textile manufacturing and floriculture, sectors that remain disconnected from digital hospitality channels. The transition toward a smart destination depends on integrating digital layers with pre-existing productive vocations through transversal innovation platforms.

Practical implications – The study supports local governance in optimizing resources and provides guidelines for the formulation of public policies aimed at the socioeconomic and digital inclusion of small producers in the territory.

Originality/value – This work addresses a gap in the application of RIS3 and smart tourism in small municipalities with primary economic matrices.

Research limitations – The investigation is limited to the analysis of formal secondary data and faces restrictions due to the informality inherent in the tourism and hospitality sector.

Keywords: Smart Tourist Destination; Smart Specialization; Productive Structure; Consumers in Tourism.

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RESUMO:

Objetivo – O artigo analisa a estrutura produtiva do município de Nova Petrópolis/RS sob a ótica das Estratégias de Pesquisa e Inovação para a Especialização Inteligente (RIS3), sugerindo diretrizes para a transição digital e qualificação da jornada dos consumidores no turismo.

Desenho/metodologia/abordagem – A abordagem quanti-qualitativa de caráter analítico-propositivo utilizou dados secundários longitudinais de empregos e estabelecimentos (2020-2024) extraídos do Ministério do Trabalho e Emprego (MTE), submetidos ao cálculo do Quociente Locacional (QL) e do Índice de Herfindahl-Hirschman (IHH).

Resultados – Os resultados apontam para uma economia concentrada na manufatura têxtil e na floricultura, setores que operam desconectados dos canais digitais de hospitalidade, em que a transição para um destino inteligente reside na vinculação de camadas digitais às vocações produtivas preexistentes por meio de plataformas transversais de inovação.

Implicações práticas – O estudo subsidia a governança local na otimização de recursos e fornece diretrizes para a formulação de políticas públicas voltadas à inclusão socioeconômica e digital de pequenos produtores no território.

Originalidade/valor – O trabalho preenche uma lacuna sobre a aplicação da RIS3 e do turismo inteligente em municípios de pequeno porte com matrizes econômicas primárias.

Limitações da pesquisa – A investigação limita-se à análise de dados formais secundários, enfrentando restrições diante da informalidade inerente ao setor de turismo e hospitalidade.

Palavras-chave: Destino Turístico Inteligente; Especialização Inteligente; Estrutura Produtiva; Consumidores no Turismo.

RESUMEN:

Objetivo: El artículo analiza la estructura productiva del municipio de Nova Petrópolis (RS) desde la perspectiva de las Estrategias de Investigación e Innovación para la Especialización Inteligente (RIS3), y propone directrices para la transición digital y la mejora de la experiencia de los consumidores en el sector turístico.

Diseño/metodología/enfoque: El enfoque cuantitativo-cualitativo, de carácter analítico-propositivo, utilizó datos secundarios longitudinales sobre empleo y establecimientos (2020-2024) extraídos del Ministerio de Trabajo y Empleo (MTE), a los que se aplicó el cálculo del Cociente de Localización (CL) y del Índice de Herfindahl-Hirschman (IHH).

Resultados: Los resultados apuntan a una economía concentrada en la industria textil y la floricultura, sectores que operan desconectados de los canales digitales de la hostelería, en los que la transición hacia un destino inteligente radica en la vinculación de las capas digitales con las vocaciones productivas preexistentes a través de plataformas transversales de innovación.

Implicaciones prácticas: El estudio respalda a la gobernanza local en la optimización de recursos y ofrece directrices para la formulación de políticas públicas orientadas a la inclusión socioeconómica y digital de los pequeños productores del territorio.

Originalidad/valor: El trabajo cubre una laguna sobre la aplicación de las RIS3 y del turismo inteligente en municipios de pequeño tamaño con estructuras económicas basadas en actividades primarias.

Limitaciones de la investigación: La investigación se limita al análisis de datos secundarios formales, lo que plantea restricciones derivadas de la informalidad inherente al sector turístico y de la hospitalidad.

Palabras clave: Destino Turístico Inteligente; Especialización Inteligente; Estructura Productiva; Consumidores en el Turismo.

INTRODUCTION

The transition to a smart tourism ecosystem represents a strategic direction for destinations seeking to strengthen their competitiveness amid rapid technological advancements. Globally, the Smart Cities and Destinations (SCDs) market is expanding at an accelerated rate. Smart ticketing, smart booking, real-time engagement, and digital destination infrastructure solutions are projected to exceed US\$44 billion by 2030 (The Business Research Company, 2026). This growth is driven by the consolidation of connectivity infrastructures such as 5G networks, Internet of Things (IoT)-based solutions, and the disruptive advancement of Generative Artificial Intelligence (AI). These technological tools enable the co-creation of integrated, personalized, and dynamic tourism experiences (Gretzel et al., 2015; Sigala, 2018; Stankov & Gretzel, 2020). However, the main challenge for public administrations lies in how to translate these complex data ecosystems into effective regional development strategies. This transition requires a design centered on human interactions to enhance the consumer journey in tourism — visitors, excursionists, and local residents who engage with the services, commerce, and infrastructure of the territory (Stankov & Gretzel, 2020).

Despite this, the predominant theoretical framework on the subject has focused on large global metropolises and mature service economies, concentrating studies on the digitalization of attractions in hyperconnected territories (Buhalis & Amaranggana, 2015; Ivars-Baidal et al., 2019; Jovicic, 2019). This centralization creates a research gap regarding how small municipalities with traditional productive structures can absorb these strategies (Romão, 2020). In this context, the Research and Innovation Strategy for Smart Specialization (RIS3) emerges as a promising methodological framework, enabling regions to map their endogenous productive vocations and design digital transition trajectories based on pre-existing knowledge (Foray, 2014; Balland et al., 2019).

To investigate this dynamic, the municipality of Nova Petrópolis/RS, located in the Serra Gaúcha Region, was used as the object of study. With an estimated population of 21,717 inhabitants distributed over an area of 291 km², the territory is marked by its Germanic cultural heritage and the title of “Garden of Serra Gaúcha” (IBGE, 2021; Nova Petrópolis Turismo, 2023). The choice of municipality is justified by its regional relevance within the Hortênsias Region — one of the main drivers of tourism in Brazil —, which ensures a consolidated flow of visitors and a high density of tourist consumption. However, although it has hospitality appeal, its formal structure is historically anchored in sectors of low technological intensity and disconnected from digital tourism channels.

It is important to highlight that the municipality is not a case where RIS3 has already been implemented. Thus, analyzing Nova Petrópolis allows us to verify the applicability of RIS3 in a small municipality that must discover how to use technology transversality and smart tourism to add value, digitize, and create innovative synergies in its economic vocations. In light of this, the following question emerges: How can the RIS3 guidelines underpin the digital transition and qualify the consumer experience in tourism in a destination with the socioeconomic matrix of Nova Petrópolis/RS?

To address this question through an analytical-propositional approach, this study aimed to analyze the productive structure of Nova Petrópolis from the perspective of RIS3, proposing strategic guidelines based on data that enable the integrated digitization of the local tourism experience. Specifically, this work seeks to map the formal economic clusters of the municipality, identify sectors with potential for related diversification, and design technological innovation platforms capable of connecting traditional productive forces to the consumption journey in the destination.

To achieve these purposes, this article adopts a quantitative-qualitative approach supported by the Location Quotient (LQ) and the Herfindahl-Hirschman Index (HHI). These indices were applied to the official longitudinal microdata on employment and establishments from the Annual Social Information Report (RAIS) and the General Register of Employed and Unemployed (CAGED) for the recent period (2020 to 2024). It is noteworthy that, from a regional economic perspective, tourism constitutes a cross-cutting activity that does not have an exclusive code in the National Classification of Economic Activities (CNAE), being distributed across the hotel, gastronomy, and retail sectors.

Thus, the work offers i) theoretical contributions by integrating regional science and tourism, ii) managerial contributions by providing a decision-making roadmap for the Municipal Government, and iii) social implications by demonstrating how technological inclusion can fairly distribute tourism income across the territory (Sigala, 2018).

Following this introduction, the theoretical framework presents the role of smart tourism in the tourist experience and its interconnection with RIS3. The third section details the methodological procedures and statistical treatments applied to the databases. The fourth section presents, analyzes, and discusses the empirical results. Finally, the concluding remarks summarize the theoretical and practical contributions, discuss the methodological limitations, and outline an agenda for future research.

SMART TOURISM FOR A BETTER TOURIST EXPERIENCE

Smart tourism represents an evolution of traditional tourism, driven by the integration of Information and Communication Technologies (ICTs) into the consumer experience in tourism. In this new configuration, technologies cease to be support tools and become transformative agents and infrastructures that redefine interactions, actors, and socio-technical contexts (Sigala, 2018). This perspective focuses on converting massive data flows into value propositions that stimulate innovation, entrepreneurship, and the competitiveness of destinations (Gretzel et al., 2015a; Li et al., 2017; Buhalis & Amaranggana, 2015; Gretzel et al., 2020).

Smart tourism seeks to improve residents' quality of life and visitor attractiveness through sustainable solutions (Romão et al., 2018; Lee et al., 2020). This transformation is based on five pillars – smart infrastructure, smart tourism technologies, accessibility and interactivity, personalized experience, and collaboration – which work synergistically to enrich the consumer journey (Shafiee et al., 2019), as shown in Table 1.

Table 1. Pillars of smart tourism implementation for the tourist experience

PILLAR	DESCRIPTION	REFERENCES
Smart infrastructure	Implement high-speed connectivity (Wi-Fi, 5G), IoT devices, and digital platforms. Facilitate interconnectivity and interoperability, consolidating internal and external ecosystems for decision-making solutions.	Zhang et al. (2022); Torabi et al. (2022); Pai et al. (2020); Buhalis & Leung (2018)
Technologies for Smart Tourism	Integrate mobile applications, augmented reality, virtual tours, and personalized recommendation systems to enrich pre-trip, on-site, and post-trip experiences. Promote exploration and refinement of choices, improving satisfaction, with human-centered design to avoid distractions.	Hien & Trang (2024); Jeong, Shin (2019); Shen et al. (2020); Pai et al. (2021); Huang et al. (2017); Stankov & Gretzel (2020); Pencarelli (2020)
Accessibility and interactivity	Ensuring digital tools are easy to use and accessible to everyone, including seniors and tourists with limited digital skills. Interactivity via real-time information, feedback, and social sharing drives engagement. Smart destination networks enhance collective innovation.	Zhang et al. (2022); Jeong, Shin (2019); Xu et al. (2023); Del Chiappa & Baggio (2015)
Personalized experience	Using data analytics and AI to tailor recommendations, itineraries, and services to individual preferences, increasing perceived value and memorable experiences. Social big data personalizes offers and predicts behaviors, boosting satisfaction and repeat visit intent.	Jeong, Shin (2019); Pai et al. (2020, 2021); Lan et al. (2021); Del Vecchio et al. (2018)
Collaboration	Fostering cooperation between governments, businesses, and technology providers for integrated, sustainable, and user-friendly ecosystems, balancing tourism growth with environmental and social preservation.	Pencarelli (2019); Archi et al. (2023)

Source: Prepared by the authors (2025).

On one hand, a technocentric approach is identified, represented by studies such as Zhang et al. (2022) and Lan et al. (2021), which define the pillars of infrastructure and personalization within the context of algorithmic efficiency and data engineering. For this group, the intelligence of a destination is proportional to its technical capacity to process Big Data and deploy Internet of Things (IoT) sensor networks. The focus lies on predictive modeling of consumer behavior and service automation, assuming that technological accuracy is the main driver of memorable experiences.

On the other hand, a human-centric and institutional counter-trend emerges, led by authors such as Stankov and Gretzel (2020) and Pencarelli (2020). These authors argue that excessive digital stimuli and real-time mobile applications can generate cognitive friction and distract consumers from the essence of the place visited. From this perspective, the pillar of Smart Tourism Technologies (STTs) is redefined: design must prioritize the holistic well-being of the individual. Regarding collaboration, governance-oriented authors such as Del Chiappa and Baggio (2015) argue that isolated technology cannot generate intelligence without inter-organizational trust networks and open channels that include local residents and small suppliers in destination decision-making.

Empirical evidence from previous studies (Torabi et al., 2022; Pai et al., 2021) indicates that isolated investments in 5G connectivity or artificial intelligence fail in small-scale destinations when the social and business fabric is not prepared to cooperate. This need to subordinate technological apparatus to governance and pre-existing economic structures justifies the interconnection between the smart tourism pillars and the RIS3 guidelines. The following section therefore discusses how RIS3 can map vocations and operationalizing the intended digital transition.

Smart Tourism and RIS3

RIS3 and smart tourism converge as complementary instruments for innovative territorial development. Developed from the European Union's cohesion policy, RIS3 is framed as a territorialized strategic approach that aims to transform the regional economic structure by concentrating public resources in priority areas of specialization (Foray, 2014). Moving away from traditional top-down planning models or the mere replication of successful ecosystems (such as the Silicon Valley model), RIS3 is based on the principle that each territory possesses unique assets and skills that serve as the engine of its own innovation.

Thus, the main objectives of RIS3 focus on: i) promoting regional economic transformation through a strategic focus on investments in science, technology and innovation; ii) maximizing the impact of structural funds through selectivity, avoiding the ineffective dispersion of resources; iii) stimulating knowledge-based competitive differentiation; and iv) modernizing sectors through the connection of new technologies.

To operationalize these objectives, the literature and regulatory guidelines of the strategy are structured around four lines of action. The first line is based on the Inclusive Territorial Diagnosis, which maps the region's pre-existing infrastructure. The second line is implemented through the Entrepreneurial Discovery process, a quadruple helix participatory governance mechanism (government, academia, businesses, and civil society) designed to identify emerging market opportunities from the bottom up. The third line of action defines the Strategic Focus, selecting a limited number of investment priorities for which the region has the capacity to generate critical mass. Finally, the fourth line establishes the Monitoring and Evaluation mechanisms so that the strategy can adapt to the fluctuations and economic shocks of the macroeconomic environment.

It is within this methodological design that RIS3 and smart tourism converge as complementary instruments for innovative territorial development. While RIS3 focuses on identifying and governing these unique productive vocations and guiding structural investments, smart tourism emerges as a socio-technical vector that translates these priorities into technological solutions applied at the end of the value chain (Lee et al., 2020; Sigala, 2018). Recent studies highlight that the RIS3 acts as a catalyst for tourism innovations by encouraging the sector to engage with cross-cutting industries, promoting inter-regional collaborations and redefining sectoral priorities. This integration is evident in frameworks such as that of the Adriatic-Ionian area, which proposes analytical tools to assess the readiness of smart destinations, fostering value co-creation and environmental sustainability (Borzyszkowski et al., 2023; Dedić et al., 2023).

Reference models, such as the Spanish DTIs system, reinforce this synergy by structuring pillars of governance, innovation, accessibility, technology, and sustainability within regional action plans. In peripheral or small-scale regions, RIS3 ensures that tourism digitalization acts as an instrument of cohesion, talent retention, and socioeconomic resilience (Alzua-Sorzabal et al., 2024; Romão, 2020).

From this perspective, smart tourism complements RIS3 by prioritizing technology infrastructure, the Internet of Things (IoT), and massive data analysis to customize services and manage information flows in real time (Li et al., 2017). In the contemporary context of smart cities and destinations, both approaches operate in an integrated way to harmonize urban attractiveness, cultural preservation, the creative economy, and the limits of environmental sustainability. Instead of promoting uncontrolled growth that penalizes local communities, the intersection of RIS3 with smart destination management mitigates potential territorial conflicts (such as overtourism or gentrification), generating shared value and protecting the quality of life of residents (Romão et al., 2018; Del Vecchio et al., 2018; Buhalis & Leung, 2018).

METHODOLOGICAL PROCEDURES

This study adopts a quantitative-qualitative approach of an analytical-propositive nature, structured in three stages. The investigation is based on the analysis of longitudinal secondary data on formal employment. To this end, microdata on active formal employment relationships and the number of establishments declared in the municipality of Nova Petrópolis/RS were extracted from the official databases of the Ministry of Labor and Employment (MTE), including the Annual Social Information Report (RAIS) and the General Register of Employed and Unemployed (CAGED) at the end of each fiscal year. The time-frame covers the period 2020 to 2024, enabling the identification of recent transformations and dynamics of the municipal economic structure. Local economic activities were disaggregated and mapped based on the National Classification of Economic Activities (CNAE 2.0), descending to the analytical levels of groups and classes.

The first step focuses on calculating the Location Quotient (LQ), an indicator used to measure the concentration of a given economic activity in the municipality relative to its participation in a broader spatial context (Florence, 1939; Crocco et al., 2006). Recognizing the limitations of the LQ when interpreted in an isolated and static manner, the approach incorporates: i) a three-year moving average for temporal smoothing and mitigation of short-term noise (Box et al., 2015); ii) the Coefficient of Variation (CV) to attest to the interannual stability of the employment stock; iii) minimum thresholds of establishments and formal jobs based on the municipal median of activities, filtering sectors of real territorial relevance (Britto & Albuquerque, 2002; SEBRAE, 2002); iv) the Temporal Stability Index (TSI), which measures the persistence of economic activity over time by identifying the proportion of years in which the sector maintains a QL above the local median; and v) bootstrap resampling to ensure consistency and statistical significance of the estimates (Efron & Tibshirani, 1993).

These criteria are applied across regional coverage radii of 100, 150, and 200 km from Nova Petrópolis. This approach mitigates the effects of the Modifiable Area Unit Problem (MAUP) (Openshaw, 1984), ensuring that political-administrative boundaries do not distort the identification of the arrangements. Thus, an economic activity is specialized if it exceeds the criteria in at least two of the three radii.

In the second stage, complementary analyses deepen the diagnosis of the specializations identified in the previous phase, establishing the link between the productive structure and market dynamics. First, intermunicipal co-occurrence is examined to detect potential synergies and productive complementarities. Second, the evolutionary dynamics of the sectors are evaluated through the Compound Annual Growth Rate (CAGR), classifying activities into strategic quadrants: stars (high QL and high CAGR), stagnant (high QL and medium-low CAGR), losing specialization (high QL and low CAGR), consolidating (medium-low QL and medium-high CAGR), or growth outliers. Third, the concentration of the economic structure is measured using the Herfindahl-Hirschman Index (HHI) (Hirschman, 1997), indicating whether the municipality has a diversified economic base or is dependent on a few dominant sectors.

To consolidate the second stage, opportunities for economic diversification are identified based on the opportunity score, calculated from the ubiquity and diversity indices. This score is based on the theory of economic complexity (Hidalgo & Hausmann, 2009; Hausmann et al., 2007), which posits that economic development depends on the capacity for diversification into complex activities (low ubiquity) and related to existing capabilities (high density). This proximity matrix (Neffke et al., 2011) ensures that opportunities are viable in the local productive context. Stratification by quartiles is adopted to classify opportunity scores and rank sectors according to their strategic potential (Tukey, 1977).

Finally, the third stage fulfills the analytical-propositive character of the study by translating the empirical findings into strategic guidelines under the governance of RIS3. This phase focuses on designing the architecture of transversal innovation platforms, demonstrating how sectors can be linked to digital layers, transforming forces into digital assets for value co-creation that enhances the end-to-end tourism experience.

DATA ANALYSIS

An examination of the employment and business data structure of the municipality reveals that “Tourism” does not appear as an economic Section or Division, as it is a cross-cutting activity, measured on the demand side (consumption). On the supply side of the formal economy, tourism is distributed across several characteristic CNAE divisions, such as Retail Trade, Accommodation (hotels), and Food Services (gastronomy).

Economic Summary of the Municipality of Nova Petrópolis

Employment figures for 2024 indicate that Nova Petrópolis is strongly anchored in three areas of industrial specialization (leather/footwear, food, and furniture), alongside a robust retail sector, as shown in Table 2.

Table 2. Percentage of jobs by CNAE SECTION/DIVISION level in Nova Petrópolis/RS

ECONOMIC SECTION/DIVISION	PART. %
Manufacturing industries	38,59%
<i>Preparation of leather and leather goods, travel goods and footwear</i>	12,73%
<i>Food product manufacturing</i>	11,47%
<i>Furniture manufacturing</i>	4,30%
Trade and repair of motor vehicles and motorcycles	14,58%
<i>Retail trade</i>	14,58%
Construction	6,90%
<i>Building construction</i>	3,73%
<i>Specialized construction services</i>	2,31%
<i>Infrastructure works</i>	0,29%
Financial, insurance and related services activities	5,68%
<i>Financial services activities</i>	5,68%
Subtotal of economic sections/divisions	65,75%
<i>Other economic sections/divisions</i>	34,25%

Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2024), active employment relationships.

Table 3 shows the participation of establishments down to the division level. The data reveal a vibrant yet highly fragmented economy, with Retail Trade (26.40%) and Accommodation (7.14%) forming the most visible components of the local economy.

Table 3. Percentage participation of establishments by CNAE SECTION/DIVISION level in Nova Petrópolis/RS

ECONOMIC SECTION/DIVISION	PART. %
Trade and repair of motor vehicles and motorcycles	31,18%
<i>Retail trade</i>	26,40%
<i>Trade and repair of motor vehicles</i>	4,78%
Manufacturing industries	16,10%
<i>Clothing and accessories manufacturing</i>	4,91%
<i>Food product manufacturing</i>	3,77%
<i>Furniture manufacturing</i>	2,11%
Construction	9,37%
<i>Specialized construction services</i>	7,14%
<i>Building construction</i>	2,23%
Construção	8,24%
<i>Serviços especializados para construção</i>	4,79%
<i>Construção de edifícios</i>	3,45%
Subtotal of economic sections/divisions	64,89%
<i>Other economic sections/divisions</i>	31,11%

Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2024), active establishments.

In this context, sustainable growth and smart specialization strategies for Nova Petrópolis should leverage the strength of its textile and retail network, as well as its tourism potential, as platforms to add value, distribute, and reinforce production across other local industrial chains. Such an approach would mitigate sectoral dependence while capitalizing on the municipality's tourism potential.

Economic Specializations of the Municipality of Nova Petrópolis

The specialization profile of Nova Petrópolis (Table 4) reveals a strong leadership in the Textile Manufacturing and Metallurgy divisions, both of which exceed regional average and demonstrate clear comparative advantages. Although the Leather/Footwear and Food sectors account for the largest absolute employment volumes (leading Table 4), the Textile/Knitting sectors have a higher relative concentration and weight in specialization. This is because the surrounding region shows limited specialization in these activities. A degree of diversification is also evident in complementary sectors, particularly clothing and accessories manufacturing, which reinforces the textile industry and suggests the presence of a structured value chain. Conversely, the absence of significant specialization in Food Manufacturing is noteworthy, considering the importance of gastronomy in tourism-driven economies. This gap signals a potential vulnerability in the sector.

Table 4. Relationship of specializations at the CNAE Group level (average QL)

ECONOMIC ACTIVITY	NP	REGION
Textile manufacturing	~85	~15
Metallurgy	~37	~22
Agriculture, livestock and related services	~30	~70
Financial services activities	~8	~10
Clothing and accessories manufacturing	~7	~5
Furniture manufacturing	~6	~20
Food manufacturing	~5	~25
Building construction	~1.5	~1.5
Non-metallic mineral extraction	~1.5	~1.5
Sports, recreation and leisure activities	~1	~20
Specialized construction services	~1	~1

Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2020-2024)

The interpretation of these indicators in light of Marshallian agglomeration economies suggests that textile and metallurgical specialization provides Nova Petrópolis with competitive advantages. The territory benefits from a specialized labor market, shared local supply of inputs and machinery, and spillovers of accumulated tacit technical knowledge. This concentration acts as a barrier to entry for external competitors and consolidates the municipality's productive identity. However, such hyper-specialization also increases vulnerability to sectoral macroeconomic shocks, such as competition from global e-commerce platforms and fluctuations in the costs of imported yarns.

Furthermore, the gap between Nova Petrópolis' specialization indices and the Serra Gaúcha averages in the Food and Leisure sectors reveals the phenomenon of "excursion tourism" or transit tourism. While neighboring municipalities in the Hortênsias Region boast a high density of restaurants, theme parks, and entertainment complexes (reflected in high QLS of approximately 25 and 20), Nova Petrópolis functions as a traditional production hub (knitwear and floriculture) and a daytime contemplative attraction. Visitors appreciate the urban landscape and the retail offerings, but tend to spend on food and nighttime entertainment in nearby cities.

Given this context, strategic guidelines should emphasize related diversification (Balland et al., 2019). Existing technological capabilities in metallurgy (automation), the botanical tradition of floriculture, and the design expertise of the textile sector can be leveraged to enhance cultural, gastronomic and personalized experiential tourism. Through digital layers and smart tourism technologies (STTs), these capabilities can be transformed into value-adding assets that retain a greater share of visitor spending within the territory..

Economic Concentration in the Municipality of Nova Petrópolis

This section analyzes the concentration of economic specializations in Nova Petrópolis (Paul Krugman, 1991), using the Herfindahl-Hirschman Index (HHI) (Herfindahl, 1997), adapted to measure the participation of specialized activities. The analysis is based on the premise that a high concentration in a few activities increases local vulnerability to sectoral shocks (Pike et al., 2007). Based on the identified specializations, the concentration is classified according to the criteria of the Federal Trade Commission (DOJ and FTC) (Table 5).

Table 5. Federal Trade Commission criteria for economic concentration.

IHH	CLASSIFICATION
>2.500	High concentration, low diversification
>= 1.500 <= 2.500	Medium concentration, medium diversification
< 1.500	Low concentration and high diversification

Source: Prepared by the authors.

In 2024, Nova Petrópolis recorded an HHI of 3,522.95, highlighting a highly concentrated and poorly diversified economy (Table 6). This concentration heightens vulnerability: a crisis in the knitwear market or a crop failure in floriculture could severely impact the economy.

Table 6. Ranking of contribution to economic concentration by division/CNAE group

ECONOMIC SECTION/DIVISION	CONTRIBUTION TO IHH
TEXTILE MANUFACTURING <i>Manufacture of knitted fabrics</i>	26,77% 26,77%
AGRICULTURE, LIVESTOCK AND RELATED SERVICES <i>Horticulture and floriculture</i> <i>Livestock farming</i>	18,65% 16,79% 1,86%
METALLURGY <i>Foundry</i>	11,67% 11,67%
MACHINERY AND EQUIPMENT MANUFACTURING <i>Manufacture of machinery and equipment for specific industrial use</i>	9,47% 9,47%
FOOD MANUFACTURING <i>Slaughtering and meat product processing</i> <i>Manufacture of other food products</i>	7,25% 3,69% 3,56%
Subtotal of economic sections/divisions	73,81%
<i>Other economic sections/divisions</i>	26,19%

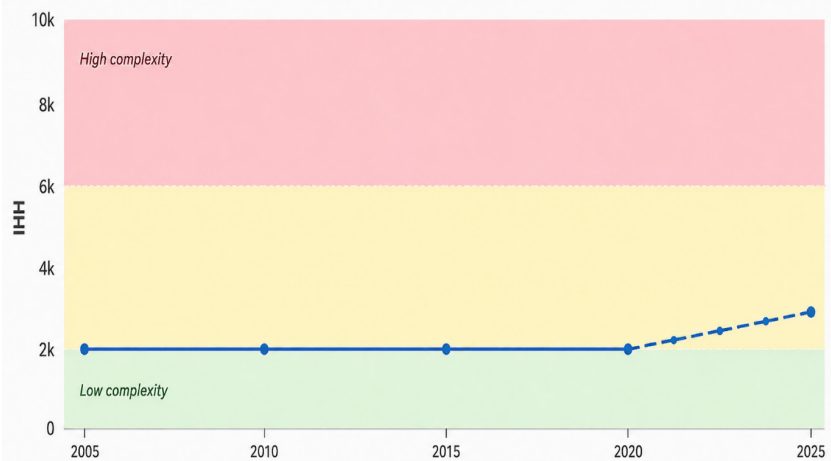
Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2024).

A cross-analysis of these data reveals a strong connection to the principles of smart tourism, particularly the concept of ubiquitous value co-creation (Buhari's & Sinarta, 2019). When results indicate a high economic concentration in knitwear manufacturing and horticulture/floriculture, smart destination engineering must respond by layering digital elements that transform these physical production chains into memorable, intangible consumer experiences. In practice, the knitwear sector should be integrated with shopping tourism; the adoption of smart tourism technologies (STTs)—such as AI-driven virtual fitting rooms and RFID-enabled smart tags—allows for the tracking of visitor preferences and seamless integration into the visitor's digital journey.

Similarly, the prominence of floriculture creates an ideal setting for Internet of Things platforms. Smart agritourism itineraries, where visitors interact with environmental sensors and access the cultural and production history of plants via QR codes, exemplify how primary and secondary economic strengths can be transformed into digitized tourism assets. Thus, the traditional economy provides the destination's substance, identity, and scale, while smart technologies provide connectivity, personalization, and efficiency, elevating the tourism experience.

This concept is applied to a longitudinal analysis, which shows that the municipality's economy has become increasingly concentrated over time, as shown in Figure 1.

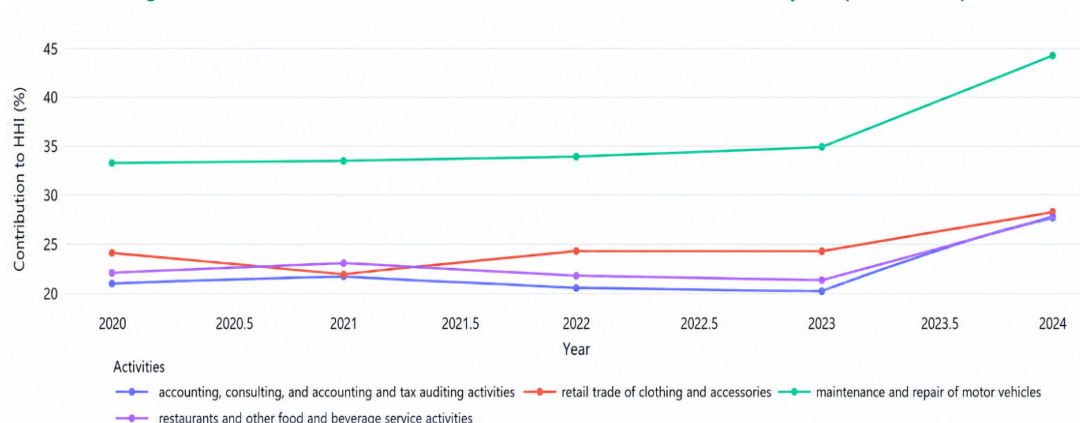
Figure 1. Evolution of economic concentration (HHI) in Nova Petrópolis (2020–2024)



Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) – RAIS/CAGED (2020–2024)

This increase was driven by the activities shown in Figure 2.

Figure 2. Contribution of economic activities to the IHH in Nova Petrópolis (2020–2024)



Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) – RAIS/CAGED (2020–2024)

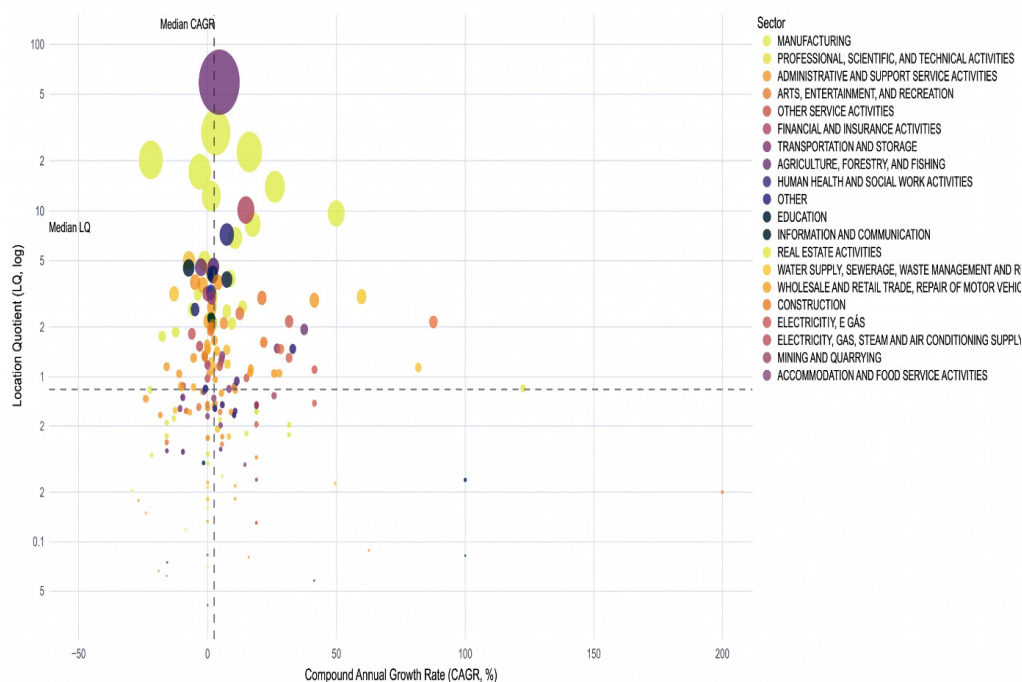
The increase in the municipality's overall concentration was not driven by its traditional industrial base, suggesting that only a few companies in these subsectors achieved an employment share disproportionate to the regional context.

Sector Dynamism Matrix

This section applies a quadrant-based representation of the life cycle of economic activities (Vernon, 1966). The classification adapts the Boston Consulting Group (BCG) portfolio matrix (Henderson, 1970) to the regional economy, supporting the strategic allocation of resources. On the vertical axis (Y), regional specialization is represented, measured by the Location Quotient (LQ). On the horizontal axis (X), dynamism is expressed by the Compound Annual Growth Rate (CAGR), which smooths short-term fluctuations and provides a comparable measure of growth.

Cutoff thresholds (dotted lines) are defined using the median as a reference, ensuring contextualization relative to regional data (Tukey, 1977). The analysis incorporates statistical significance through confidence intervals, reducing noise and increasing reliability (Hidalgo & Hausmann, 2009), see Figure 3.

Figure 3. Classification of activities into quadrants



Note: Upper right quadrant indicates sectors with high QL, high CAGR. Lower right quadrant indicates sectors with high CAGR, low QL. Upper left quadrant indicates sectors with high QL, low CAGR. Lower left quadrant indicates sectors with low QL, low CAGR. Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2020-2024).

The positioning shows that 56.25% of the municipality's activities fall into the high-QL, high-CAGR quadrant (Stars), including "Manufacturing Industries" and "Agriculture, Livestock, Forestry Production, Fishing and Aquaculture". This indicates that the municipality's traditional economic pillars are not stagnant; they remain dynamic and competitive. Another 40.62% are classified as Mature/Stagnant, forming a dense and diversified quadrant, with a strong presence of services such as "Commerce" (orange), "Accommodation and Food" (pink) and "Education" (dark blue).

Regarding resource allocation, the matrix offers an empirical basis for prioritizing investments. It serves as a strategic tool for regional economic planning, aligning decisions with sectoral dynamics and development needs, adapted to the territorial granularity of Nova Petrópolis.

Economic Activities with Strong Growth

This section seeks to identify sectors in Nova Petrópolis that exhibit marked variations in growth – positive or negative – classified as outliers. The analysis is based on the principle that differentiated performance is only meaningful when it deviates significantly from the regional pattern (Isard, 1960). The procedure is structured in three stages: (i) Homogeneous comparison, contrasting the growth of a specific activity with the same sector in municipalities where the activity is present; (ii) Identification of outliers via Tukey's Interquartile Range (IQR) (1977); (iii) Contextual interpretation, analyzing the mean and median of the regional CAGR to situate local performance. These findings are listed in Tables 7 and 8.

Table 7. Positive outlier economic activities identified for Nova Petrópolis

ECONOMIC ACTIVITY	NP	REGION
Construction of highways, railways, urban works and special engineering structures.	~200%	~5%
Information technology services activities	~100%	~5%
Data processing, application service providers and internet hosting services	~95%	~5%
Coffee roasting and grinding	~90%	~5%
Manufacture of other food products	~80%	~8%
Veterinary activities	~78%	~5%
Travel agencies and tour operators	~38%	~5%

Note: NP: Nova Petrópolis. Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2020-2024).

Table 8. Negative outlier economic activities identified for Nova Petrópolis

ECONOMIC ACTIVITY	NP	REGION
Footwear manufacturing	-5%	+5%
Wholesale trade specializing in other products	-5%	+5%
Livestock farming	-6%	+5%
Manufacture of knitwear and tricot articles	-8%	+3%
Retail trade of construction materials	-10%	+3%
Horticulture and floriculture	-12%	+5%
Manufacture of canned fruits, vegetables and other produce	-15%	+5%
Storage, loading and unloading	-15%	+1%
Stone dressing and manufacture of other non-metallic mineral products	-16%	+3%

Note: NP: Nova Petrópolis. Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2020-2024).

The data reveals negative outlier sectors possibly influenced by exogenous factors such as regional recessions or structural changes, reflecting sectoral vulnerabilities that require diversification and resilience strategies. Conversely, the data also points to a set of positive outliers in sectors associated with the new economy, such as information technology services, data processing, and internet hosting. This local performance suggests that the municipality is not only exploring new, high value-added vocations but also revitalizing traditional industrial clusters. In this sense, the analysis contributes to policymakers' understanding the localized nature of sectoral challenges.

Economic Opportunities for the Municipality of Nova Petrópolis

This section presents an analysis aimed at identifying opportunities for productive diversification, offering a dynamic diagnosis for economic development trajectories. The approach is structured around a presence matrix, based on the 75th percentile of the Location Quotient (LQ), selecting representative activities and avoiding over-densification or excessive dispersion. Proximity (relative co-occurrence) and density (sum of proximities with existing activities) are calculated following Hausmann e al. (2007). The opportunity index combines high density (affinity with local capacities) and low ubiquity (rarity), highlighting such activities as strategic and supporting the prioritization of economic diversification trajectories. The results are summarized in Table 9.

Table 9. Participation in economic opportunities for the municipality of Nova Petrópolis

ECONOMIC ACTIVITY	NP
Financial Services Activities	6,13%
Wholesale Trade, Except Motor Vehicles...	5,04%
Manufacture of Machinery and Equipment	5,04%
Manufacture of Chemical Products	4,83%
Education	3,44%
Metallurgy	3,39%
Insurance, Reinsurance, Supplementary Pension Plans...	3,00%
Manufacture of Computer Equipment, Electronic Products...	2,73%
Auxiliary Activities of Financial Services...	2,72%
Filmmaking Activities, Video Production...	2,63%
Warehousing and Auxiliary Transport Activities	2,28%
(Other sectors < 2% each)	...
TOTAL	100,00%

Note: NP: Nova Petrópolis. Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2020-2024).

The distribution of opportunity scores indicates a polycentric fabric that reduces vulnerabilities and increases resilience (Boschma, 2015). Prominent sectors include financial services (6.13%), reinforcing the base for tourism fintechs, such as microcredit applications for local entrepreneurs. Wholesale trade (5.04%), machinery and equipment manufacturing (5.04%), and the chemical industry (4.83%) emerge as high-density opportunities, aligned with manufacturing, with potential for tourism supplies (e.g., eco-friendly packaging). These sectors also reflect historical capabilities and potential for added-value chains (Frenken et al., 2007). Strategic services such as education (3.44%) and insurance (3.0%) highlight knowledge-based vocations, while emerging services such as information technology (2.73%) and cultural activities (2.28%) suggest technological and tourism niches.

Smaller sectors, such as pulp and paper, pharmaceuticals, and transportation, form a latent stock of diversity that can be mobilized through innovation policies, strengthening the local ecosystem. Sectors such as Human Health Care (4%), Transportation (6%), Metallurgy (3%), Insurance and Pension (3%), and Information Technology and Electronic Products (2.73%) signal knowledge-intensive vocations suitable for personalization via big data, such as cultural wellness itineraries. Niches such as Film Production (2.28%), Sports Activities (2%), and Pharmaceutical Products (2%) represent emerging sectors with low ubiquity, capable of being leveraged for digital ecotourism or immersive audiovisual content, promoting inclusion and sustainability (Shafiee et al., 2019).

In summary, the structure of economic opportunities in Nova Petrópolis highlights a territory that encompasses sectoral diversity with specialization in strategic hubs. Sectors such as the machinery industry, chemicals, and education can position the municipality as a center of knowledge and high value-added production.

Economic Vulnerabilities of Nova Petrópolis

The analytical logic applied in this stage serves as a diagnostic tool for structural weaknesses in the local economy, focusing on activities present in the territory that have not consolidated as specializations and exhibit instability. This aligns with contemporary approaches to resilience and regional vulnerability (Pike et al., 2007; Martin, Sunley, 2015).

Three criteria are considered: i) persistent non-specialization ($QL < 1.0$); ii) low participation in the territory's economy; and iii) instability (high Coefficient of Variation of the QL). These criteria are evaluated longitudinally through moving averages and counts of years with low QL, complemented by adaptive thresholds (30th and 70th percentiles) that adjust the analysis to the local reality and prevent biases from absolute values.

This methodology resonates with regional resilience (Martin, Sunley, 2015), highlighting non-specialized, marginal, and unstable activities (Table 10) – such as private education, administrative activities, information and communication, and transportation and storage – as structural breaking points. These divisions, below the regional average and lacking consistent growth trajectories, reflect external dependence (influence of exogenous factors such as investment cycles) and low structural insertion (absence of thriving local chains), contrasting with consolidated sectors such as tourism and clothing. Despite the vulnerabilities, these gaps represent strategic potential, provided that public policies prioritize workforce qualification, innovation, and cooperation, distinguishing unrecoverable activities from those that can be strengthened in the productive system of Nova Petrópolis.

Table 10. Ranking of economic activities identified as vulnerable in the context of Nova Petrópolis.

ECONOMIC ACTIVITY	NP	REGION
Extraction of non-metallic minerals	~0.78	~0.10
Artistic, creative and entertainment activities	~0.40	~0.20
Agriculture, livestock and related services	~0.25	~0.25
Manufacturing of food products	~0.20	~0.18
Specialized construction services	~0.20	~0.20
Activities of associative organizations	~0.20	~0.20

Note: NP: Nova Petrópolis. Source: Prepared by the authors based on data from the Ministry of Labor and Employment (MTE) - RAIS/CAGED (2020-2024).

In summary, the proposal provides a proactive and contextualized diagnosis of local productive vulnerabilities, offering support so that policymakers can prioritize sectors that require support, restructuring, or strategic diversification.

Structural Articulation: From Economy to Smart Tourism via RIS3

Given the panorama presented, a central question emerges for the development of the territory: if the Herfindahl-Hirschman Index (IHH) of Nova Petrópolis demonstrates high economic concentration centered on the Manufacture of Knitted Fabrics and Horticulture/Floriculture, how can Smart Tourism act as a risk mitigation and diversification mechanism? From the perspective of regional planning, such figures might suggest that the municipality should be treated strictly as a manufacturing and agricultural hub, detached from discussions of innovation in services. However, under the logic of RIS3, they constitute the starting point for the digital transition (Foray, 2014). Regional data intelligence serves to convert these preexisting specializations into dynamic competitive advantages through digital transition (Balland et al., 2019).

To address this challenge, TTIs must be mobilized as “transversal innovation platforms”. In practice, the hyper-specialization of the knitwear sector can be given new meaning in the tourist experience through the use of Augmented Reality (AR), interactive mirrors and virtual fitting rooms in retail establishments, transforming the act of purchase into a technological entertainment product and memorable shopping tourism (Jeong, Shin, 2019). Likewise, the prominence of floriculture and horticulture in the local economy enables the creation of smart agritourism routes operated by Internet of Things (IoT) sensors and traceability systems via QR-Codes. These tools allow visitors to track, in real time, the origin and cultural landmarks of what they consume and contemplate in the “Jardim da Serra Gaúcha”.

This direction promotes what Boschma (2017) conceptualizes as related diversification, expanding the local economy beyond the physical production of goods by adding a layer of digital added value. As Sigala (2018) argues, technology in tourist destinations acts as a catalyst for value co-creation. By digitally connecting the dominant industrial base and floriculture to the Accommodation and Food divisions, Nova Petrópolis mitigates vulnerabilities associated with high sectoral concentration. Smart tourism is no longer treated as an isolated domain; it becomes a socio-technical vector capable of digitalizing, integrating and unifying the municipality’s economic matrix.

FINAL CONSIDERATIONS

These results were subsequently deepened through a qualitative analysis in order to map the synergies between the value chains and the sectors of the Nova Petrópolis territory. From this diagnosis, Experiential Tourism and Associated Services for territorial development were identified as a strategic innovation platform, summarized in Table 11. This platform aims not only to attract tourist consumers, but also to increase their length of stay and spending, transforming them into high value-added experiences.

In this sense, the transition to smart tourism should not be interpreted as a mere modernization of promotional practices, but as a process of productive diversification capable of generating chain effects across multiple sectors. Digitalization can enhance the efficiency of accommodation and food services, integrate logistics chains, foster creative activities (such as audiovisual production and experience design) and attract technology-based entrepreneurs.

Placed within the broader context of regional development policies, the digitalization of the tourism experience in Nova Petrópolis can be understood as a structural transformation project that strengthens economic resilience by reducing vulnerabilities linked to exclusive dependence on traditional tourism. By generating data-driven territorial intelligence, expanding cooperation between stakeholders, and enhancing the destination’s visibility, the digital transition can contribute not only to tourism competitiveness but also to the consolidation of a regional innovation ecosystem.

Table 11. Implications for the transition to smart tourism

ANALYSIS COMPONENT	MAIN FINDINGS	IMPLICATIONS FOR SMART TOURISM VIA RIS3
Economic Concentration	IHH of 3,522.95 in 2024, indicating high concentration. Main structural contributions: Knitwear manufacturing (26.77%) and Horticulture/Floriculture (18.65%). Temporal evolution demonstrates a recent increase driven by apparel retail and food services.	High concentration increases vulnerability to shocks. The RIS3 strategy should create digital layers (STTs) in retail and food services (integrated platforms), capturing tourist flow to distribute local production.
Economic Dynamism	56.25% of activities are in the Star quadrant (high QL and high CAGR), including Manufacturing and Agriculture. Another 40.62% are Mature/Stagnant, with a strong presence of Commerce, Accommodation and Food Services.	Traditional pillars remain competitive. New vocations are emerging in mature tourism services, requiring technological interventions to sophisticate the offer and transition to the DTI model.
Growth Outliers	Significant regional deviations (IQR). Positive outliers: IT services, data processing/hosting and travel agencies (~38%). Negative outliers: Knitwear manufacturing (-8%) and horticulture/floriculture (-12%).	Positive outliers in technology and agency reveal the native domains for accelerating local digital platforms. Declines in mesh and flowers sound the alarm about the urgency of data-driven innovation.
Diversification Opportunities	Polycentric fabric of opportunity scoring. Key sectors include: Financial Services (6.13%), Wholesale Trade (5.04%), Machinery Manufacturing (5.04%), and Chemical Products Manufacturing (4.83%).	Promote related diversification. Link financial services to tourism (local fintech companies to foster it) and utilize manufacturing and automation capacity for smart and sustainable tourism supplies.

Source: Prepared by the authors (2025).

This study promotes an epistemological convergence between evolutionary economic geography and the governance of tourist destinations, demonstrating that economic data analysis is a prerequisite for designing digitalization policies. For public managers, tourism councils, and development entities, the study offers a practical roadmap, focused on innovation platforms that optimize public resources in digital infrastructure connected to the local production matrix.

As limitations of this work, the exclusive use of longitudinal secondary data on employment and formal establishments is noted, which obscures the dynamics of the informal economy in the hospitality and service sectors. To overcome this limitation, future research should incorporate data collected directly from tourism consumers. Additionally, future studies could assess the longitudinal impacts of the digital transition on the tourist experience. Applying Big Data and text-mining methodologies to digital review platforms (such as TripAdvisor, Booking, and Google Maps) would allow the structural economic mapping presented here to be compared with subjective experience, mobility flows, and value perception.

In short, the combination of RIS3 with smart tourism emerges as a transformative vector, potentially positioning Nova Petrópolis as a prototype of innovative territorial development, balancing cultural tradition and digital modernity to achieve resilient and inclusive tourist attractiveness.

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