Regional Knowledge Potential and Tourism Innovation in Poland: A Multi-criteria Analysis

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Abstract: The paper investigates the knowledge-based determinants of tourism innovation potential in Polish regions and their relevance for smart tourism development. The primary objective is to assess how regional knowledge resources, learning capabilities, and information-processing conditions influence innovation readiness within the tourism sector. Tourism innovation potential is conceptualized not only as a set of infrastructural or technological indicators but also as a component of regional knowledge ecosystems that enable the creation, diffusion, and practical application of knowledge in tourism-related activities. The analysis is based on statistical data from the Polish Central Statistical Office, including indicators related to the information society, research and experimental development, and enterprise innovation activity, complemented by selected tourism-related variables. Together, these indicators form an operational framework for assessing how regions accumulate, manage, and utilize knowledge resources relevant to tourism innovation. To measure this potential, the study applies a multi-criteria decision-making approach combining Hellwig's method and the TOPSIS method. Eleven diagnostic variables were selected, including ten stimulants and one destimulant. Both methods generate standardized synthetic measures of knowledge-based tourism potential within the range [0,1]. Based on these measures, Polish regions were classified into four typological groups representing different levels of knowledge maturity, absorptive capacity, and innovation readiness. A further stage of the analysis examines the relationship between knowledge-driven innovation potential and actual tourism performance. Two indicators of tourist movement were used: the density of tourist movement (WG) and Schneider's tourism intensity index (WS). Spearman's rank correlation analysis indicates a strong positive relationship (rs = 0.90–0.95), suggesting that regions more effective in mobilizing and utilizing knowledge resources tend to attract higher tourist flows. At the same time, several regions with only moderate knowledge potential record relatively high tourism activity, which may reflect effective knowledge-management practices, institutional learning mechanisms, or strong regional cooperation networks. The findings reveal significant regional disparities in the creation and utilization of knowledge within the Polish tourism sector and highlight the importance of strengthening regional knowledge-management systems-such as digital infrastructure, innovation networks, and mechanisms of knowledge exchange - to enhance regional competitiveness and support smart tourism development.

Keywords: Knowledge management, Tourism, Innovation potential, Multi-criteria analysis

1. Introduction

In recent years, the growing importance of knowledge as a strategic resource has significantly reshaped the understanding of regional development processes, particularly in sectors characterized by high levels of service intensity and innovation, such as tourism. Contemporary approaches emphasize that regional competitiveness is increasingly determined not only by tangible assets, but also by the ability to generate, absorb, and utilize knowledge within complex socio-economic systems (Cooke et al., 2007). In this context, tourism is undergoing a transformation towards knowledge-driven and innovation-oriented models, where intellectual capital, absorptive capacity, and network-based knowledge exchange play a critical role in shaping development trajectories (Gürlek, 2020; Wu, 2020; Raisi et al., 2020). At the same time, the emergence of smart tourism highlights the growing relevance of digital technologies, data ecosystems, and learning processes as key enablers of innovation and value creation in tourism destinations (Ye et al., 2020). Despite the increasing recognition of these factors, there remains a need for comprehensive empirical approaches that integrate knowledge-based determinants with measurable indicators of tourism performance at the regional level. Therefore, the main objective of this study is to assess the role of regional knowledge potential as a determinant of tourism innovation in Poland, using a multi-criteria analytical framework that captures both structural and functional dimensions of knowledge systems. The study contributes to the existing literature by linking the concept of regional knowledge ecosystems with tourism innovation potential and by providing an empirical assessment of spatial disparities in knowledge-driven development processes.

2. Literature Review: Knowledge-based Determinants, Innovation Potential, and Smart Tourism Development

2.1 Knowledge Systems and Innovation Processes in Tourism

The growing importance of knowledge as a strategic resource has significantly reshaped the theoretical foundations of tourism development. Within the knowledge-based economy framework, knowledge is no longer perceived as a complementary factor but rather as a core determinant of innovation and competitive advantage. Regional development is thus increasingly driven by the capacity to generate, integrate, and utilize knowledge resources, rather than by the mere availability of material assets (Cooke et al., 2007).

In this context, regional knowledge potential reflects a system's ability to combine competencies, learning processes, and network relationships that enable the diffusion and application of knowledge, particularly in sectors such as tourism, where innovation is often intangible and experience-based. Tourism development is strongly embedded in local knowledge systems, as the uniqueness of tourism products frequently derives from place-specific resources and cultural contexts. Consequently, learning and knowledge adaptation processes play a crucial role and are inherently co-evolutionary, emerging from interactions among actors and continuous adjustments to institutional and environmental conditions (Cristofaro et al., 2020; Dias et al., 2023).

A central component of knowledge-based development is intellectual capital, encompassing human, structural, and relational dimensions. Human capital, encompassing employees' knowledge, skills, and competencies, represents a fundamental factor shaping innovation in tourism, particularly in the context of entrepreneurship and the development of new business models (Chou et al., 2020). In tourism, intellectual capital is particularly significant due to the centrality of service quality and customer experience. Human capital provides the competencies necessary for innovation, relational capital facilitates access to external knowledge and supports value co-creation, while structural capital ensures the organizational infrastructure for knowledge management (Gürlek, 2020; Liu, 2020). Their interaction enhances firms' adaptive capacity and innovation performance (Khalique et al., 2020; Liu et al., 2017).

The effective use of knowledge resources is closely linked to absorptive capacity, defined as the ability to acquire, assimilate, and apply external knowledge (Binder, 2018). In tourism, where innovation often results from combining diverse knowledge sources, absorptive capacity plays a pivotal role. It is embedded in organizational routines and learning mechanisms (Ponce-Espinosa et al., 2020) and acts as a mediator between intellectual capital and innovation outcomes (Wu, 2020).

At the regional level, knowledge transfer and diffusion processes underpin innovation systems. Knowledge circulates through formal and informal networks, fostering innovation and new business models (Raisi et al., 2020). In the fragmented tourism sector, collaborative networks are particularly important, as they facilitate access to diverse knowledge sources and enhance innovation capacity (Arcese et al., 2021). These processes foster the creation of innovation and the diversification of economic activities, which is particularly significant in the context of the development of new tourism products and initiatives based on cross-sectoral collaboration (Schuhbert et al., 2020).

2.2 Tourism Innovation Potential: Drivers and Assessment

Tourism innovation potential can be conceptualized as a systemic capacity to generate, absorb, and implement innovations within a regional context. Innovation extends beyond observable outputs and reflects broader capabilities related to learning and adaptation (Wu, 2020). This perspective aligns with the resource–capability–performance framework, in which knowledge resources and intellectual capital shape organizational capabilities that determine innovation outcomes.

The determinants of tourism innovation are multidimensional, encompassing both internal organizational factors and external environmental conditions. Key drivers include intellectual capital, organizational capabilities, and collaborative networks, which jointly influence the ability to generate and implement innovations (Gürlek, 2020; Khalique et al., 2020). Access to external knowledge and participation in networks further enhance innovation performance by increasing the diversity and intensity of knowledge flows (Binder, 2018; Raisi et al., 2020).

Tourism enterprises play a central role in these processes, acting as agents that transform knowledge into innovative products and services. Their innovation capacity depends on both internal resources, such as intellectual capital and absorptive capacity, and external conditions, including access to digital technologies and

knowledge infrastructures. The development of ICT and digital platforms enables new business models and service personalization (Ye et al., 2020), while collaboration with research institutions supports knowledge transfer and innovation implementation (Dias et al., 2023).

The measurement of tourism innovation potential remains challenging due to its intangible and multidimensional nature. Empirical studies typically rely on composite indicators capturing aspects such as ICT development, research and development (R&D) intensity, and firms' innovation activity (Ye et al., 2020; Suryandaru, 2020). However, these measures should be complemented by qualitative dimensions, including organizational capabilities, network relationships, and learning processes, to fully capture the complexity of innovation systems.

2.3 Digital Transformation and the Emergence of Smart Tourism

The transition towards smart tourism represents a natural evolution of knowledge-based and innovation-driven development. Smart tourism is defined by the integration of digital technologies, data, and knowledge to enhance decision-making processes, service quality, and user experiences. Smart destinations leverage advanced ICT solutions to facilitate stakeholder interactions and optimize resource management (Ye et al., 2020).

Digital technologies and data form the foundation of smart tourism ecosystems, characterized by interconnected networks of enterprises, institutions, and users that co-create value through continuous information exchange. In these ecosystems, data function as a strategic resource, enabling innovative business models, operational efficiency, and adaptability to changing market conditions (Liu, 2020; Wu, 2020).

Smart tourism is also embedded in knowledge ecosystems that support the creation, diffusion, and application of knowledge across multiple actors. These ecosystems rely on dynamic interactions and collaborative processes that foster innovation and value co-creation (Raisi et al., 2020). Intellectual capital and absorptive capacity remain critical enablers, as they allow organizations to integrate diverse knowledge sources and translate them into innovative solutions (Gürlek, 2020; Ponce-Espinosa et al., 2020).

From a regional perspective, smart tourism contributes to both competitiveness and sustainability. Regions that effectively leverage digital technologies and knowledge resources are better positioned to develop innovative tourism products and achieve superior economic performance (Ye et al., 2020). At the same time, smart tourism supports sustainable development through more efficient resource management and reduced environmental impact (Cristofaro et al., 2020).

3. Methodology

The objective of the present study was to assess how regional knowledge resources, learning capabilities, and information-processing conditions influence innovation potential within the tourism sector in Poland. The analysis was conducted using newly released statistical datasets from the Polish Central Statistical Office, including Information Society in Poland (Central Statistical Office, 2024), Research and Experimental Development in Poland (Central Statistical Office, 2023b), Innovation Activity of Enterprises (Central Statistical Office, 2023a), as well as additional indicators from the Local Data Bank identified as stimulants of tourism development in Poland (Central Statistical Office, 2024). Based on these datasets, the key components constituting the tourism innovation potential were identified.

The research applied a multi-criteria decision-making framework integrating Hellwig's (1968) taxonomic method and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). As noted by Hwang and Yoon (1981), TOPSIS represents a methodological extension of Hellwig's approach. Both techniques enable the linear ordering of spatial units according to their respective levels of tourism innovation potential, thereby supporting a comprehensive and comparative statistical evaluation.

In both analytical frameworks, a consistent notation scheme was applied. The parameter m denotes the number of observed units, corresponding in this study to the territorial regions of Poland. The parameter n represents the number of diagnostic variables, classified as either stimulants or destimulants affecting the level of tourism innovation development. Both methodological approaches yield synthetic indicators that enable the linear ordering of regions according to their tourism innovation potential. The resulting rankings were subsequently compared with indicators of tourist traffic density and intensity, conceptualized in accordance with Schneider's definitions. The overall research procedure was adopted from the methodological framework developed by Synówka-Bejenka (2017).

Hellwig's taxonomic method was employed to compute a synthetic development measure, producing values on a normalized scale from 0 to 1. Within this interval, a value of 0 reflects the weakest similarity to the ideal development pattern, whereas a value of 1 indicates the strongest similarity. In parallel, the TOPSIS method was used to derive a synthetic indicator representing the tourism potential of each region. The resulting values also ranged from 0 to 1, with 0 corresponding to the lowest potential and 1 to the highest.

The degree of association between the two rankings derived from the aforementioned synthetic measures was assessed using Spearman's rank correlation coefficient (r_s). This non-parametric statistic assumes values within the interval [−1, 1] and is defined by the following formula:

$$r_s = 1 - \frac{6\sum_{i=1}^{m} o_i}{m(m^2-1)}$$

where:

o_i - denotes the difference between the positions occupied by the i-th region in the two rankings under comparison

m – represents the total number of regions.

The coefficient r_s measures the strength and direction of the monotonic relationship between the rankings, with values approaching 1 indicating a strong positive correlation, values near −1 indicating a strong negative correlation, and values close to 0 suggesting the absence of a monotonic association.

The Hellwig's method

a) Standardization of variables

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}$$

i =1,2,…,m

j= 1,2,…,n

b) Determining the value of the development pattern

$$z_j^+ = \begin{cases} \max\limits_i \{z_{ij}\} \\ \min\limits_i \{z_{ij}\} \end{cases}$$

max= variable X_j is the stimulant

min= variable X_j is the destimulant

c) Determining the distance of Euclidean objects from the development pattern

$$d_i^+ = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - z_j^+\right)^2}$$

i =1,2,…,m

j= 1,2,…,n

d) Determining a taxonomic measure of development

$$d_i^H = 1 - \frac{i_i^+}{\bar{d} + 2s_d}$$

where: $\bar{d} = \frac{1}{m}\sum_{i=1}^{m} d_i^+$ and $s_d = \sqrt{\frac{1}{m}\sum_{i=1}^{m}\left(d_i^+ - \bar{d}\right)^2}$

The TOPSIS method

a) normalization of variables

$$= \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

i =1,2,…,m

j= 1,2,…,n

b) Determination of the value of the ideal object z^+ (from the Hellwig's method) and the anti-ideal object z^-

$$z_j^- = \begin{cases} \max_i \{z_{ij}\} \\ \min_i \{z_{ij}\} \end{cases}$$

$\max_i \{z_{ij}\}$ *when variable Xj is the stimulant*

$\min_i \{z_{ij}\}$ *when variable Xj is the destimulant*

c) Determining the distance of Euclidean objects from an ideal and non-ideal solution

$$d_i^+ = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - z_j^+\right)^2} \qquad d_i^- = \sqrt{\sum_{j=1}^{n} \left(z_{ij} - z_j^-\right)^2}$$

i =1,2,…,m

j= 1,2,…,n

d) Determining the synthetic index

$$d_i^T = \frac{i_i^-}{i_i^+ + i_i^-}$$

i =1,2,…,m

4. Selection of Diagnostic Variables

For the purposes of the comparative statistical analysis, a total of eleven diagnostic variables were selected. Of these, ten were classified as stimulants, indicating that they exert a positive influence on the measured outcome. In contrast, variable X4 was designated as a destimulant, reflecting its negative effect on the outcome. Among the available statistical data, the authors selected the following determinants of regional knowledge potential specifically oriented toward fostering tourism innovation in Poland:

X_1 - share of net revenues from sales of innovative products in total net revenues from sales in 2022

X_2 – percentage of innovative service enterprises in the years 2020–2022

X_3 – innovative enterprises that cooperated in terms of innovation activity in % of total enterprises in 2023

X_4 – registered unemployment rate in 2024

X_5 – expenditures on innovation activities in service enterprises - per 1000 inhabitants in 2023

X_6 – enterprises with high and very high level of the digital intensity index in 2023

X_7 – The Bank Millenium "eco index" 2024

X_8 – intramural expenditure on R&D by voivodships in 2023 (current prices)

X_9 – number of lodging facilities per 100 km²

X_{10} – length of tourist trails per 100 km² (km)

X_{11} – gastronomic enterprises with more than 9 employees per 100 km²

The selection of variables was guided by two principal criteria: their relevance to the innovation potential of the tourism sector and a sufficiently high coefficient of variation. For each variable included in the analysis, we

calculated key descriptive statistics, including minimum and maximum values, arithmetic means $\bar{x}_j$, standard deviations S_j, and classical coefficients of variation V_j. All computed values are presented in detail in Table 1.

Table 1: Descriptive characteristics of the diagnostic variables

Specification	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
Minimum	0.00	10.60	2.60	3.00	11.56	10.70	29.00	0.14	66.63	8.76	1.82
Maximum	4.70	41.40	17.60	8.70	3104.69	31.20	61.00	6.24	657.88	57.01	21.54
$\bar{x}_j$	1.73	28.74	7.03	5.79	487.05	18.39	45.50	1.62	258.63	24.52	6.61
S_j	1.21	9.82	4.37	1.73	734.03	4.86	8.46	1.77	199.96	12.45	5.58
V_j	0.70	0.34	0.62	0.30	1.51	0.26	0.19	1.09	0.77	0.51	0.84

Source: Own calculations based on the Central Statistical Office (2022a, 2022b, 2023a, 2023b, 2024a, 2024b) and Bank Millenium (2024) report.

5. Regional Classification of Polish Regions by Knowledge Potential Supporting Tourism Innovation

The values of the taxonomic measures derived from Hellwig's method and the TOPSIS procedure—calculated on the basis of the eleven selected diagnostic variables—served as the foundation for constructing the ranking of the analyzed regions and are presented in Table 2.

Table 2: Synthetic measures and their regional ranges across polish voivodeships

Region	The Hallwig's method d_i^H	Ranking position R_H	Change of the ranking position	Ranking position R_T	TOPSIS d_i^T
Lower Silesia	0.5224795	2	1	1	0.147863957
Kuyavia-Pomeranian	0.2796473	6	8	14	0.122589395
Lublin Voivodeship	0.1885717	12	1	11	0.124260214
Lubusz Voivodeship	0.2517231	9	3	12	0.123544956
Łódź Voivodeship	0.2635930	7	1	6	0.128233500
Lesser Poland	0.4899253	3	1	2	0.140361788
Masovia	0.5521146	1	2	3	0.135416701
Opole Voivodeship	0.1630040	14	1	13	0.122995090
Subcarpathia	0.2509942	10	2	8	0.126112684
Podlaskie Voivodeship	0.1678331	13	3	10	0.124437622
Pomerania	0.3952826	5	0	5	0.132019856
Silesian Voivodeship	0.4090261	4	0	4	0.131387298
Holy Cross Voivodeship	0.0864152	15	1	16	0.117030386
Warmian-Masurian Voivodeship	0.0856267	16	1	15	0.119523073
Greater Poland	0.1988857	11	4	7	0.127900641
West Pomerania	0.2576487	8	1	9	0.124921801

Source: Own calculations based on the Central Statistical Office (2022a, 2022b, 2023a, 2023b, 2024a, 2024b) and Bank Millenium (2024) report.

A statistical analysis was carried out using eleven diagnostic variables to evaluate the tourism innovation potential of Polish regions. Descriptive statistics for each variable – including minimum and maximum values, arithmetic means, standard deviations, and classical coefficients of variation – are presented in Table 2. The coefficient of variation (V_j) illustrates the relative dispersion of each diagnostic variable. The highest variability is observed for X_5 – expenditures on innovation activities in service enterprises per 1,000 inhabitants (V_j=1.51), followed by X_8 - intramural R&D expenditures at the voivodeship level (V_j=1.09), and X_{11} – the density of gastronomic enterprises with more than nine employees per 100 km² (V_j=0.84). In contrast, variables such as X_7

– the Bank Millennium "Eco Index" 2024 (V_j=0.19) and X_6 – the share of enterprises with high or very high levels of the Digital Intensity Index (V_j=0.26) display relatively low variability.

To assess regional differences, the study employed Hellwig's method and the TOPSIS technique to compute taxonomic measure values for each voivodeship. These synthetic measures formed the basis for ranking the regions according to their tourism innovation potential. The resulting values and rankings are provided in Table 2. According to Hellwig's method, the Masovian Voivodeship ranks first (d_i^H = 0.552), indicating the strongest tourism innovation potential, followed by Lower Silesia (d_i^H = 0.522) and Lesser Poland (d_i^H = 0.490). The lowest potential is recorded for the Warmian-Masurian and Holy Cross Voivodeships (both d_i^H =0.086).

The TOPSIS results reveal a slightly different ordering. In this case, Lower Silesia occupies the top position (d_i^T = 0.148), followed by Lesser Poland (d_i^T = 0.140) and the Masovian Voivodeship (d_i^T = 0.135). The voivodeships with the lowest tourism innovation potential according to TOPSIS are Holy Cross (d_i^T = 0.117) and Warmian-Masurian (d_i^T = 0.119).

In Table 3, a detailed classification of the regions into four typological groups, based on their tourism innovation potential, is presented. According to Hellwig's method, regions assigned to the "very high" potential category (Class I) include Masovia, Lower Silesia, and Lesser Poland. Regions exhibiting "high" potential (Class II) comprise the Silesian Voivodeship and Pomerania. The "medium" potential group (Class III) encompasses the Kuyavia–Pomeranian Voivodeship, Łódź Voivodeship, Lubusz Voivodeship, West Pomerania, Subcarpathia, Greater Poland, Lublin Voivodeship, and Opole Voivodeship. Finally, the "low" potential category (Class IV) includes the Holy Cross Voivodeship and the Warmian–Masurian Voivodeship.

Table 3: Taxonomic classification of the investigated regions

Measure values $d_i^{H/T}$	Class	Tourism potential	Region
According to the value of Hellwig's development measure			
$d_i^H \geq 0.4278$	I	Very high	Masovia, Lower Silesia, Lesser Poland
$0.4278 > d_i^H \geq 0.2852$	II	High	Silesian Voivodeship, Pomerania,
$0.2852 > d_i^H \geq 0.1426$	III	Medium	Kuyavia-Pomerania, Łódź Voivodeship Lubusz Voivodeship, West Pomerania, Subcarpathia, Greater Poland, Lublin Voivodeship, Opole Voivodeship
$d_i^H < 0.1426$	IV	Low	Holy Cross Voivodeship, Warmian-Masurian Voivodeship
According to the value of the synthetic TOPSIS meter			
$d_i^T \geq 0.1357$	I	Very high	Lower Silesia, Lesser Poland
$0.1357 > d_i^T \geq 0.1280$	II	High	Masovia, Pomerania, Silesian Voivodeship, Łódź Voivodeship
$0.1280 > d_i^T \geq 0.1204$	III	Medium	Greater Poland, Subcarpathia, West Pomerania, Podlaskie Voivodeship, Lublin Voivodeship, Lubusz, Opole Voivodeship, Kuyavia-Pomerania,
$d_i^T < 0.1204$	IV	Low	Warmian-Masurian Voivodeship, Holy Cross Voivodeship

Source: Own calculations based on the Central Statistical Office (2022a, 2022b, 2023a, 2023b, 2024a, 2024b) and Bank Millenium (2024) report.

A comparable four-group classification was also produced using the TOPSIS method. According to this approach, regions with "very high" potential are Lower Silesia and Lesser Poland. The "high" potential group (Class II) consists of Masovia, Pomerania, the Silesian Voivodeship, and the Łódź Voivodeship. Regions classified as having "medium" potential (Class III) include Greater Poland, Subcarpathia, West Pomerania, the Podlaskie Voivodeship, Lublin Voivodeship, Lubusz Voivodeship, Opole Voivodeship, and the Kuyavia–Pomeranian Voivodeship. The "low" potential regions identified by the TOPSIS method are the Warmian–Masurian Voivodeship and the Holy Cross Voivodeship.

Although some differences occur in the specific ranking positions and group allocations between the two methods, a notable consistency is evident in identifying both the highest- and lowest-performing regions. Lower Silesia, Lesser Poland, and Masovia repeatedly appear among the top-ranking regions, albeit with slight positional shifts, while the Holy Cross and Warmian–Masurian Voivodeships consistently occupy the lowest positions across both classifications. The "Change of the ranking position" column in Table 3 further illustrates these discrepancies, indicating the relative movement of regions between the Hellwig and TOPSIS rankings. Altogether, these findings provide a comprehensive overview of regional disparities in tourism innovation potential within Poland.

Figures 1 and 2 summarise the classification results. Figure 1 ranks the voivodeships by the two synthetic measures and their typological class, while Figure 2 shows the spatial distribution of the classes across Poland, making the regional disparities directly comparable between the Hellwig and TOPSIS approaches.

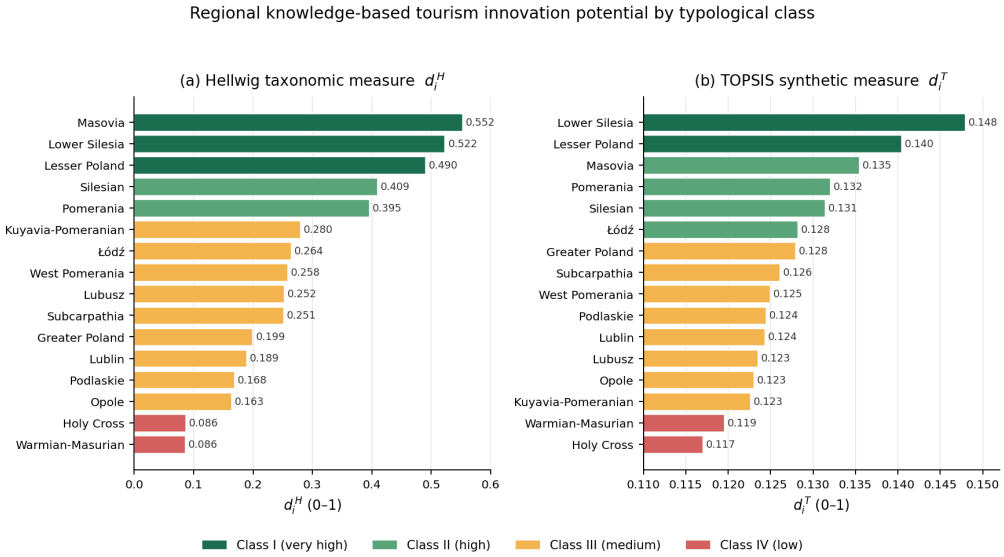

Figure 1: Regional knowledge-based tourism innovation potential by typological class — Hellwig taxonomic measure (d_i^H) and TOPSIS synthetic measure (d_i^T)

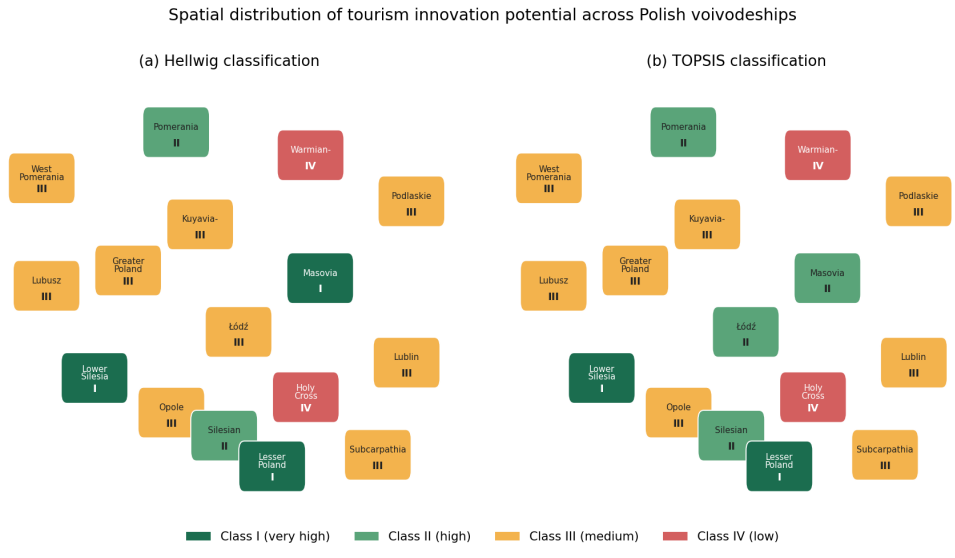

Figure 2: Spatial distribution of tourism innovation potential across Polish voivodeships under the Hellwig and TOPSIS classifications

6. Results and Discussion: Tourism Innovation Potential and Tourist Traffic

To further assess how effectively the regions translated their innovation potential into actual tourism activity, the results were compared with indicators reflecting the number of individuals using accommodation services

in 2023. Based on data from the Polish Central Statistical Office (Central Statistical Office, 2024), two indicators were applied: tourist traffic density (WG), defined as the number of persons using accommodation services during the year per square kilometre of area, and tourist traffic intensity according to Schneider (WS), defined as the ratio of individuals using accommodation services during the year to the total number of inhabitants.

Table 4: Movement density indicator and Schneider indicator

Region	Movement density indicator W_G	Ranking position R_G	Change of the ranking position	Ranking position R_S	Schneider indicator W_S
Lower Silesia	210.39	3	1	4	145.75
Kuyavia-Pomeranian	78.88	7	0	7	71.02
Lublin Voivodeship	47.42	13	3	10	59.23
Lubusz Voivodeship	4640	14	6	8	66.56
Łódź Voivodeship	71.67	8	4	12	55.27
Lesser Poland	376.16	1	1	2	166.53
Masovia	176.19	5	0	5	113.69
Opole Voivodeship	36.66	15	1	16	36.83
Subcarpathia	66.85	9	2	11	57.59
Podlaskie Voivodeship	28.72	16	1	15	50.93
Pomerania	189.22	4	1	3	146.83
Silesian Voivodeship	220.84	2	7	9	63.04
Holy Cross Voivodeship	53.56	11	2	13	53.68
Warmian-Masurian Voivodeship	53.23	12	6	6	94.76
Greater Poland	62.45	10	4	14	53.40
West Pomerania	149.41	6	5	1	209.60

Source: Own calculations based on the Central Statistical Office (2022a, 2022b, 2023a, 2023b, 2024a, 2024b) and Bank Millenium (2024) report.

Table 4 presents actual tourist traffic in 2023. The Lesser Poland and Silisian Voivodeships exhibit the highest density of tourist movement (WG), whereas Podlaskie and Opole record the lowest values. West Pomerania demonstrates the highest tourism intensity (WS) relative to its population, while Opolskie and Holy Cross rank lowest in this respect. Changes in regional rankings, such as the advancement of West Pomerania in terms of WS, reflect differences in the effectiveness with which regions capitalize on their tourism potential.

To assess the strength of tourism innovation potential utilization, Spearman's rank correlation coefficient (r_s) was recalculated. The analysis indicates a high degree of concordance between rankings obtained using both taxonomic methods, based on the WG and WS indicators. The values of these indicators are reported in Table 5. The results reveal a very strong (0.90–0.95) and positive correlation between innovation potential (as measured by the Hellwig and TOPSIS methods) and actual tourist traffic (WG, WS), suggesting that regions with higher tourism innovation potential tend to attract a larger number of tourists.

Table 5: The Spearman's rank correlation coefficients

Coefficients	d_i^H	d_i^T
W_G	$r_s = 0.95$	$r_s = 0.94$
W_S	$r_s = 0.93$	$r_s = 0.90$

Source: Own calculations based on the Central Statistical Office (2022a, 2022b, 2023a, 2023b, 2024a, 2024b) and Bank Millenium (2024) report.

Based on a comprehensive analysis of regional innovation potential in tourism – integrating results derived from the Hellwig and TOPSIS methods with tourist traffic indicators – several key conclusions can be drawn. A strong and highly consistent positive relationship is observed between a region's tourism innovation potential and its tourist movement indicators, namely the density of tourist movement (WG) and the intensity of tourist movement according to Schneider (WS).

The exceptionally high values of Spearman's rank correlation coefficient (ranging from ranging from rs = 0.90 to 0.95) indicate a substantial degree of concordance, demonstrating that regions characterized by higher levels of innovation potential in tourism tend to exhibit greater tourist activity. This finding suggests that investments in tourism innovation are effectively translated into measurable increases in tourist flows.

Despite the strength of these correlations, an examination of individual regional rankings reveals important nuances in the extent to which regions effectively exploit their innovation potential. For example, although Masovia consistently occupies leading positions in terms of innovation potential (1st according to the Hellwig method and 3rd based on TOPSIS), it ranks only 5th with respect to both tourist movement density (WG) and Schneider's tourism intensity indicator (WS). In contrast, West Pomerania, characterized by a moderate level of innovation potential (8th in Hellwig and 9th in TOPSIS), attains the top position in terms of Schneider's intensity indicator (WS). This discrepancy suggests that factors beyond innovation potential – such as effective destination marketing, natural endowments, or geographical advantages – may play a significant role in shaping tourist traffic patterns.

Regions consistently exhibiting high levels of innovation potential, such as Lower Silesia, Lesser Poland, and Masovia, also tend to demonstrate strong tourist movement indicators. In contrast, regions characterized by lower innovation potential, including Holly Cross and Warmian-Masurian, consistently record lower levels of tourist activity. These findings provide robust evidence that the development of tourism innovation constitutes a critical pathway for enhancing tourist flows and strengthening regional competitiveness. Accordingly, policy interventions should prioritize investments in key stimulant variables (X1–X3, X5–X11), while simultaneously addressing the negative effects of destimulants, particularly unemployment (X4). The results offer a solid empirical foundation for the design of targeted, evidence-based strategies aimed at unlocking and fully exploiting tourism innovation potential across all Polish regions.

7. Conclusions

The selected determinants discussed in this article, particularly those relating to Regional Knowledge Potential and Tourism Innovation, play a critical role in understanding how destinations develop competitive advantages in an increasingly dynamic tourism environment. Innovations constitute a central driver of tourism development, enabling the creation of new products and services that respond to evolving consumer expectations while strengthening market positioning. Contemporary solutions - especially those associated with smart tourism ecosystems - have become essential for optimizing destination management, personalizing visitor experiences, and enhancing the efficiency of resource allocation.

An analysis of regional knowledge potential reveals a strong positive relationship between a region's innovation capacity and the volume of tourist traffic it attracts. This finding suggests that investments in knowledge-based assets and innovation-oriented activities translate directly into higher levels of tourism activity. However, a closer examination of regional disparities shows that not all areas fully capitalize on their knowledge potential. Some regions characterized by substantial innovation capabilities demonstrate only moderate tourist flows, while others with relatively lower innovation potential still manage to attract visitors effectively - likely due to factors such as strong branding, targeted marketing strategies, or favourable infrastructural conditions. Regions that consistently exhibit high regional knowledge potential tend to record equally robust indicators of tourist traffic, implying successful integration of innovation into their tourism offer. In contrast, regions with lower levels of innovation capacity generally show reduced density and intensity of tourist activity, underscoring the broader importance of knowledge-driven innovation as a determinant of regional tourism attractiveness.

These findings indicate that strengthening tourism innovation grounded in regional knowledge potential is essential for enhancing both tourist flows and overall regional competitiveness. Policy interventions should therefore prioritize investment in the drivers of regional knowledge creation and innovation, while simultaneously addressing the barriers that inhibit their diffusion. The varying degrees of correlation between knowledge potential and tourism performance highlight the need for region-specific, adaptive development strategies that reflect local socio-economic and institutional contexts.

The study's limitations include a relatively narrow set of diagnostic variables and the cross-sectional character of the analysis, which may not fully capture the dynamic evolution of tourism markets. Although strong correlations between knowledge potential and tourist activity were observed, the exclusive reliance on quantitative measures restricts deeper insight into the mechanisms through which knowledge assets shape innovative performance. Future research should expand the analytical framework by incorporating broader variable sets, applying longitudinal approaches, and employing mixed-methods designs. Such methodological advancements would provide a more comprehensive understanding of how regional knowledge potential influences tourism innovation and would strengthen the empirical basis for evidence-informed policy development.

Ethics Declaration: We didn't need ethical clearance for the research referred to in this paper.

AI Declaration: We didn't use an AI tool in the development of the paper.

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