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Strategic Application of AI Tools in Enhancing Tourism for SMEs: The Tourist Management in the Seismic Risk Areas

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The aim of this research is to investigate the convergence of digitization, seismic risk, and tourist management, focusing specifically on small and medium-sized firms in the tourism sector. This research examines the strategic application of digital technology to mitigate the adverse effects of earthquakes on the tourism sector and promote the long-term sustainability of these businesses. The research investigates the level of digitalization across 252 accommodation facilities and their geographical distribution in relation to varying degrees of seismic hazard. Furthermore, the research suggests the development of a digital tourism portal designed to provide real-time information in the aftermath of earthquakes. This tool aims to support local small and medium-sized enterprises by integrating artificial intelligence tools, thereby promoting both safety and sustainable economic growth.

Keywords: *Digitalization, Tourism Sector, Seismic Risks, Resilience, AI Tools.*

Introduction

Tourism is an essential component of the global economy that supports economic expansion, creates employment opportunities, and contributes to social advancement (Zhang et al. 2021). Despite its importance, its reliance on infrastructure and natural resources exposes it to risks from natural disasters like earthquakes (Xiao et al. 2022). Seismic risk—a term describing the probability of adverse effects or anticipated losses stemming from seismic events and regional vulnerabilities (Jena et al. 2020)—constitutes a significant challenge for destinations situated in earthquake-prone areas. The repercussions include diminished employment opportunities, fewer tourists, and reputational damage to affected destinations (Akamavi et al. 2023, Mazzocchi and Montini 2001). Moreover, tourists' risk perceptions significantly influence their travel choices, directly affecting the competitiveness of these locations (Akamavi et al. 2023, Scott and Gössling 2015). In this scenario, embracing digital technologies provides substantial opportunities to tackle these issues by enabling the creation of innovative strategies to boost the resilience of tourist destinations. Digital tools, including digital twins that model risk scenarios and digital communication platforms, facilitate efficient information sharing during emergencies, thereby improving the safety of both tourists and locals (Lagap and Ghaffarian 2024, Ye et al. 2022). Concurrently, analytics and Artificial Intelligence (AI) technologies assist small and

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medium-sized enterprises (SMEs) in responding to evolving consumer preferences and boosting tourist engagement and loyalty (Kanwal et al. 2023, Rane et al. 2023). Utilizing social media and integrated digital platforms not only increases the visibility of destinations but also helps in gathering essential feedback for service enhancement (Sharma and Sharma 2024, Di Virgilio 2022).

Based on our knowledge (Web of Science, Google Scholar, and Scopus), present understanding of the intersection between the level of digitalization of SMEs and seismic risk exposure in tourism is limited. While most studies in the field have only focused on the resilience, restoration, redevelopment, and valorization of architectural heritage to protect it from natural disasters and climate change (Mocerino et al. 2024, Aktürk and Hauser 2025, Vegas et al. 2022), and on how digital transformation influences organizational resilience and affects organizational performance and employees' state optimism (He et al. 2023), no previous study has specifically investigated if digitalization contributes to mitigating the effects of seismic risk on tourism and if the level of digitalization among accommodation facilities may be associated with their exposure to seismic risk. Thus, this research explores the following question:

> RQ1: Does digitalization contribute to mitigating the effects of seismic risk on tourism and promoting the resilience of tourist destinations?

The analysis was based on a dataset from Confartigianato and provides comprehensive insights into 252 accommodation facilities located in the Molise region. Molise, based on data from the National Institute of Geophysics and Volcanology, reports a significant seismic risk; this allows for greater emphasis in the analysis. The dataset includes 20 variables, both quantitative and qualitative, divided into six categories. These categories consist of digital contact information, social media presence, and registration on booking platforms. By integrating this dataset with seismic hazard data from the Molise Region—classifying municipalities into three risk zones based on Peak Ground Acceleration (PGA)—this study examines the relationship between the level of digitalization in accommodation facilities and their exposure to seismic risk.

An innovative aspect of this study is the proposal for a digital tourism portal designed to provide real-time updates on post-earthquake conditions while supporting local SMEs in economic development (Sharma and Sharma 2024, Tien et al. 2023). This tool would not only improve communication with tourists by reassuring them during emergencies but also collect useful data through AI tools to identify new trends and develop targeted marketing strategies that ensure sustainable growth for the tourism sector (Rane et al. 2023).

Literature Review

Digitalization of SMEs in the Tourism Sector

Embracing digital technologies is essential for enhancing the competitiveness and ensuring the sustainable development of the tourism sector. Employing new technologies such as AI, virtual reality, and big data enables firms to enhance service quality, optimize business operations, and foster innovation, so ensuring a sustainable competitive advantage in the market (Chen 2024, Mick et al. 2024). The adoption of Information and Communication Technologies (ICT) has transformed market dynamics and management approaches, making it easier and more flexible for tourism SMEs to commercialize their offerings (Lara et al. 2017). Beyond operational enhancements, digitalization bolsters the sector's resilience by lessening the impact of crises—such as those triggered by the COVID-19 pandemic—through increased tourism consumption and fiscal support (Tang 2024). Moreover, the adoption of digital tools is essential for sustaining corporate stability and assuring long-term viability (Surya et al. 2022). Digital transformation encompasses an array of technologies, including artificial intelligence, such as DeepSeek and chatbots; virtual reality; augmented reality; big data; and the Internet of Things (IoT), which enhance efficiency and revolutionize customer experiences through personalization and improved resource management (Kindzule-Millere and Zeverte-Rivza 2022, Jha 2024). The development and implementation of virtual experiences—initially accelerated by the restrictions imposed during the COVID-19 pandemic—underscore their potential not only as a temporary response, but also as a long-term integrative component, especially when supported by the strategic use of AI tools (Amarendra and Das 2022). Mobile applications like DepApp (Kırcı et al. 2023) and web platforms (Verrucci et al. 2016) provide real-time information and practical guidance for earthquake response. Immersive tools, such as virtual reality and serious games (Feng et al. 2020), improve behavioral preparedness, while advanced technologies like Digital Twin (Yu et al. 2023), cloud computing, and IoT (Cheng et al. 2021) facilitate simulation and emergency coordination. Alternative communication systems (Parlar et al. 2024, Centelles et al. 2021), peer-to-peer applications (Han et al. 2016), and machine learning-based solutions (Abdalzaher et al. 2023) are also noteworthy. Key domains, such as social media and mobile booking applications, significantly influence consumer decisions and necessitate organizational adaptation (Paul et al. 2024). The use of video material on social media platforms such as Facebook, Flickr, Instagram, LinkedIn, Pinterest, Twitter, and YouTube is widely recognized as a pivotal strategic asset for the tourism sector. This method enhances and promotes places engagingly, strengthens emotional connections with visitors, and creates new economic opportunities (Di Virgilio and Das 2023a). Social media should not be viewed solely as communication tools; instead, they must be acknowledged as strategic marketing platforms capable of influencing the behavioral decisions of other customers through user interactions (Di Virgilio et al. 2017). A social media campaign may aim to enhance customer loyalty, a goal made more complex by the difficulty of precisely assessing users' emotions and sentiments (Di Virgilio et al. 2024). The amalgamation of social media-driven service innovation and mobile booking applications

augments sustainable development in the tourism and hospitality sector by enhancing service quality, minimizing environmental impact, and promoting sustainable leadership (Zada et al. 2025, Polukhina et al. 2025). Digital booking systems and social media engagement enhance travel experiences by making them more immersive and interconnected while also promoting sustainable tourism through improved accessibility and innovative services (Tandafatu et al. 2024, Zada et al. 2025). The concepts of Tourism 4.0 and smart tourism destinations focus on minimizing tourism's environmental impact and encouraging sustainable practices by utilizing digital technologies to offer highly personalized and engaging experiences for tourists (Pencarelli 2019, Kindzule-Millere and Zeverte-Rivza 2022). Studies indicate that digital tools can significantly boost rural tourism income, especially when tailored to the unique characteristics of natural and cultural landscapes (Zhang et al. 2025, Alonso et al. 2024). The use of digital platforms for booking and information dissemination has improved the efficiency and sustainability of tourism services, reducing environmental impacts and increasing resource availability (Polukhina et al. 2025).

However, SMEs frequently face difficulties in adopting digital solutions due to limited financial resources, a lack of personalized strategies, and insufficient technological skills, preventing them from fully utilizing these advancements (Mick et al. 2024, Zhang et al. 2022a). Nonetheless, SMEs that successfully integrate digital tools can unlock new opportunities and strengthen their competitive position (Kindzule-Millere and Zeverte-Rivza 2022, Jha 2024).

Seismic Risk in Tourism

Seismic risk, which refers to the likelihood of surpassing a certain impact level due to earthquakes, poses a major threat to tourism by causing physical damage, economic losses, and social disruption (Brillinger 1982, Carreño et al. 2007, Carreño et al. 2011, Jena et al. 2020, Akamavi et al. 2023). SMEs, particularly micro-businesses, face difficulties in disaster preparedness due to financial barriers and restricted access to resilience tools (Orchiston 2012, Orchiston 2013). Earthquakes pose major threats to infrastructure, disrupting transportation, food supply networks, and accommodation services, underscoring the importance of robust seismic risk management strategies (Orchiston 2012, Mäntyniemi 2012). A key component of risk mitigation is seismic risk assessment, which evaluates the probability and impact of earthquakes on tourism infrastructure to improve preparedness (Hosseinpour et al. 2021). Effective communication of seismic risks to crisis management teams, particularly in tourists' home countries, ensures that at-risk travel destinations are properly assessed (Mäntyniemi 2012). The role of digitalization in enhancing SMEs' resilience in earthquake-prone areas is vital, especially in developing nations. Research on SMEs in Aceh, Indonesia, demonstrates how digital technologies, such as cloud computing and e-commerce, support risk management by ensuring business continuity and adaptability during seismic events (Chan et al. 2023).

Lessons drawn from past crises, such as the COVID-19 pandemic, emphasize that innovation and adaptability are essential for effectively managing external disruptions, providing important guidance for seismic risk readiness (Rastegar et al. 2023). Moreover, how tourists perceive seismic risk significantly impacts their

travel choices, directly affecting the competitiveness of various destinations (Akamavi et al. 2023). Risk perception is a key element of tourist behavior, affecting how travelers evaluate destinations and make travel decisions. When perceived risk is high, it can decrease the impact of positive destination image and motivation on intention to travel (Caber et al. 2020). Despite perceived risks, tourists persist in revisiting and endorsing destinations, especially when environmental concerns are not viewed as major impediments (Setiawan et al. 2024). In earthquake-prone regions, the tourism sector prioritizes digitalization and the rebuilding of trust. The central goal is to deliver a secure, dependable, and high-quality experience to visitors by leveraging advanced technologies and protocols that emphasize personal safety (Di Virgilio and Das 2023b)

Digital technology, particularly remote sensing, has grown significantly, improving capacities for environmental monitoring, agriculture, and urban planning. The combination of AI and machine learning with remote sensing has revolutionized data processing in Earth sciences. AI approaches, particularly deep learning, have been utilized for tasks such as image classification, land cover mapping, and change detection, exhibiting superior effectiveness compared to traditional methods (Chen et al. 2023, Janga et al. 2023). These technologies provide the optimal distribution of emergency resources and the precise identification of disaster sites, hence enhancing the efficacy and efficiency of emergency planning (Zhang et al. 2022b). Artificial Intelligence, when incorporated with cloud-based platforms, enables bidirectional communication, hence aiding in the collecting and analysis of data to formulate effective management strategies for disasters and severe weather events. This enhances the resilience of communities by allowing real-time data transmission and reception (Gupta et al. 2022). The development of intelligent remote sensing satellites presents opportunities for real-time, personalized data services, though issues related to privacy and data sharing need to be addressed (Zhang et al. 2022c).

Mobile platforms are fundamental in improving visitors' readiness by offering real-time information on risks and safety protocols while ensuring privacy (Aliperti and Cruz 2020, Psaroudakis et al. 2021). These instruments are necessary for efficient risk management and emergency response, especially for natural catastrophes and pandemics. Nevertheless, enhancing user awareness and adoption continues to pose a barrier that necessitates focus (Aliperti and Cruz 2020).

Resilience in Supporting SMEs

Resilience is vital for the longevity of tourism SMEs, allowing them to face crises and recover efficiently. Essential resilience factors include supply chain collaboration, strategic HR management, and adaptability (Seow et al. 2024). SMEs that emphasize innovation, product development, and technology integration demonstrate higher crisis adaptability (Sepúlveda and Bustamante-Caballero 2024). Entrepreneurial connections and a proactive approach to risk also contribute to resilience by encouraging adaptation (Dias et al. 2022). Leadership, employee training, and internal management methods are crucial for maintaining business continuity (Núñez-Ríos et al. 2022). Digital transformation, including virtual reality, allows SMEs to maintain business operations and expand their market reach during crises (Sánchez and Palos-Sánchez

2020, Sepúlveda and Bustamante-Caballero 2023). Additionally, governance, stakeholder engagement, and risk assessments play vital roles in reinforcing resilience and improving tourism performance (Caluza 2024). Strong community ties also support SMEs during crises by providing additional resources and assistance (Dahles and Susilowati 2015, Dias et al. 2022).

Methodology

Study Area

The study focuses on the Molise region, a small and less-studied region located in southern Italy. Molise is characterized by a predominantly rural setting with a developing tourism sector, making it an interesting case for analyzing the digitalization of accommodation facilities located in seismically active zones. Indeed, the region encompasses all three seismic risk categories (low-, medium-, and high-risk zones), which allows for an integrated analysis of how seismic risk may relate to digitalization levels. This diverse risk profile adds a valuable dimension to the study, as it enables exploring potential spatial correlations between seismic vulnerability and digital adoption among local hospitality businesses.

Data Collection and Sample

This study is based on a secondary analysis of data gathered from two principal sources: Confartigianato and the Molise Region. Confartigianato is a leading Italian association that monitors SMEs performance, digital transformation, and regional business risks. The analysis was conducted on accommodation facilities listed in the Confartigianato registry of SMEs, and only those that voluntarily agreed to participate were included in the study.

The assessment of digitalization was based on data provided directly by Confartigianato, which collected information on the online presence and digital tools adopted by each participating facility. While this approach may limit generalizability to the broader population, it ensures data reliability by relying on verified information from a trusted institutional source.

The initial dataset offers comprehensive information on 252 accommodation SMEs in Molise, encompassing 20 variables that reflect both quantitative and qualitative variables.

The quantitative variables were divided into 6 clusters. Digital contact variables (Cluster 1) include the presence of an email, a landline phone number, a mobile number, and a website. Cluster 2 concerns the presence of the structure on social media, considering platforms such as Facebook, Flickr, Instagram, LinkedIn, Pinterest, Twitter, and YouTube. Cluster 3 includes the presence on digital platforms (booking apps), such as TripAdvisor, Booking, Hotels.com, Airbnb, and Trivago. In addition, the dataset contains the geographical coordinates of the structure (Cluster 4), expressed in latitude and longitude, and two qualitative variables: the type of structure (Cluster 5), which distinguishes between Bed and Breakfast, Farmhouse Stay,

Guesthouse, Holiday Home, Hotel, Resort, Scattered Hotel and Tourist Residence, and the municipality of residence, recorded as a textual variable (Cluster 6).

Table 1. *Accommodation Types and Definitions*

Accommodation Type	Definitions
Bed and breakfast	Private residences and small buildings frequently serve as venues for bed and breakfast establishments, offering breakfast services and a distinctive rural ambiance (Lin et al. 2024). These establishments, often available for rent, generate revenue by providing individual rooms and breakfasts made from locally sourced ingredients, thereby contributing to sustainable development and enhancing rural resilience (Fan et al. 2023, Liu et al. 2023, Greene 2022).
Farmhouse Stay	Farmhouse accommodations provide distinctive experiences in rural settings, enabling guests to reconnect with cultural heritage and engage in educational activities related to agriculture (Fanelli and Romagnoli 2020). These establishments contribute to sustainable economic development by incorporating local cultural and historical elements, reducing environmental impact, and bolstering the local economy. Farmhouse stays are a sustainable choice for rural tourism development (Confalonieri 2011).
Guesthouse	Guesthouse refers to different forms of autonomous short-term accommodations, including tourist apartments, tiny residences, and local lodgings, utilized for vacations and temporary visits. Guesthouses may consist of a standalone residence or a single floor within a structure (Ferreira et al. 2020). This category of accommodations generally contains smaller, often family-operated enterprises, providing a more private experience for tourists. Guesthouses offer a more adaptable and personal experience than conventional hotels (Troisi et al. 2023).
Holiday Home	Holiday homes foster family unity and social bonding, promoting a dynamic "family flow" that enhances the holiday experience for both parents and children (Larsen 2013). Holiday homes serve as a "home away from home," fostering a sense of belonging and strengthening familial bonds through shared experiences and carework (Cheong and Sin 2019,; Frochot et al. 2019).
Hotel	A hotel is a type of tourist accommodation that provides lodging, meals, and other services for travelers and tourists; varies in size, function, and cost; and is typically categorized by its level of service, amenities, and location. They often belong to a broader chain or brand, influencing tourists' perceptions and experiences (Papallou et al. 2024, Seo and Shulga 2024, Sharma et al. 2022).
Resort	A resort is a destination that provides an extensive array of amenities and recreational activities, typically situated in picturesque or vacation-oriented locales. The concept of a resort revolves around delivering an all-in-one vacation experience, merging accommodation, culinary services, and leisure activities (Papallou et al. 2024). Resorts are freqiently associated with luxury and comfort, have a major impact on both the development and sustainability of tourism regions (Liu et al. 2021, Shafiee et al. 2020, Makuzva and Ntloko 2021).
Scattered Hotel	The scattered hotel is a horizontally arranged complex with accommodations distributed among multiple edifices in a village, all within pedestrian proximity to a central main building (Fissi et al. 2020, Montis et al. 2015, Confalonieri 2011). This model utilizes a unique business strategy that facilitates value creation by cultivating cultural and emotional ties between entrepreneurs and the local community, consequently providing

	innovative services designed to improve the guest experience (Fissi et al. 2020, Presenza et al. 2019).
Tourist Residence	Tourist residences are a form of accommodation that offer a more domestic environment for travelers, frequently including amenities such as kitchens and living areas. These accommodations are typically utilized for extended stays and may be part of a larger complex or exist as standalone units (Liu et al. 2021). Tourist residences appeal to travelers that search a more autonomous and adaptable lodging option, often combining features of both hotels and vacation rentals (Zasali et al. 2023, Chilufya et al. 2019).

Source: Authors' own work

The variables associated with contacts, social media, and booking applications were converted into a binary format, designating a value of 1 for presence and 0 for absence. A Normalized Digitization Index was developed to evaluate the digitization of accommodation facilities, determined by the ratio of the number of digital characteristics present to the maximum feasible number (16)—based on Cluster 1, Cluster 2, and Cluster 3. This method allows obtaining a value between 0, which indicates the total absence of digitization, and 1, which represents the maximum achievable level.

The second dataset provides information on the regional distribution of peak ground acceleration (PGA), a parameter that quantifies the maximum ground acceleration during a seismic event and a key factor in the formulation of seismic damage scenarios (Mendicelli et al. 2022).

This dataset categorizes communities into three seismic hazard zones: ZONE 1: High hazard, ZONE 2: Medium hazard, and ZONE 3: Low hazard.

The integration of the two datasets involved correlating seismic hazard data with accommodation facilities according to their municipality, facilitating an examination of the correlation between digitization levels and seismic risk across various regions.

Data Analysis

Data analysis was carried out utilizing R, adhering to a stringent methodological approach. The analysis comprised two components. The initial analysis comprised descriptive statistics to encapsulate the primary attributes of the sample, including means, medians, standard deviations, and frequency distributions, alongside significance tests, notably the chi-square test (χ^2) and Cramér's V, to evaluate the existence and intensity of statistically significant correlations among categorical variables. The second part of the analysis includes seismic risk data to assess which accommodation facilities are most vulnerable to seismic risk.

Results

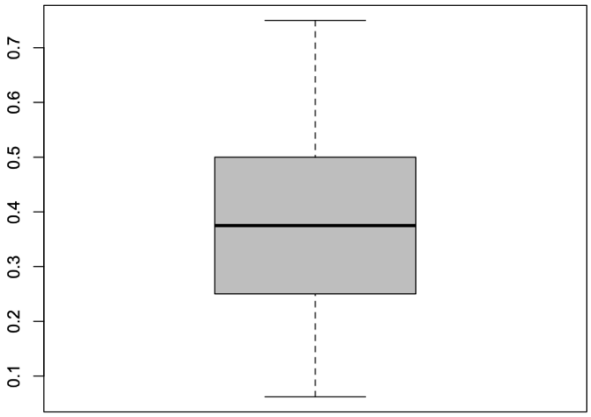
Distribution

There were 252 accommodation facilities; among them, 0.79% were resorts, 1.19% were scattered hotels, 2.78% were farmhouses, 3.97% were tourist residences, 5.95% were holiday homes, 10.32% were hotels, 21.83% were guest houses, and 53.17% were bed and breakfasts.

Measurement Model

Based on the Normalized Digitization Index, digitization classes have been created that include all structures, regardless of type: low, medium, and high. All the accommodation facilities in the dataset have a medium level of digitization, as shown in the box plot (see Figure 1). The distribution can be illustrated using a box plot, which shows no presence of outliers. This absence suggests that there are no data points that are isolated, indicating that the structures demonstrate consistent digitization behavior, with none standing out as notably different.

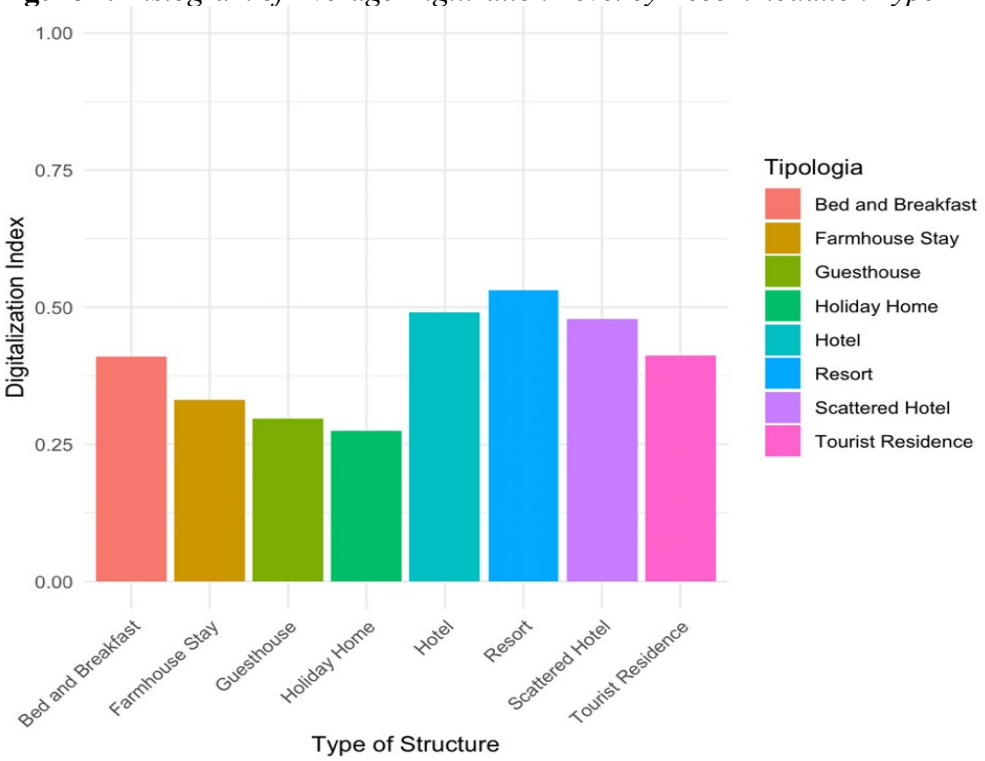
Figure 1. *Box Plot of Digitalization Index*



Source: Authors' own work

The box, which represents the interval from the first quartile (Q1 ≈ 0.25) to the third quartile (Q3 ≈ 0.5), shows that the central 50% of establishments have digitalization levels between 0.25 and 0.5. The digitalization level of the accommodations in the dataset is generally moderate, with a concentration in the 0.25–0.5 range. Analyzing the average digitalization level for each type of establishment was beneficial, as it offered insights into how various accommodation categories have adopted digital tools and technologies (see Figure 2).

Figure 2. *Histogram of Average Digitization Level by Accommodation Type*



Source: Authors' own work

In the results, Table 1, the distribution of the digitalization index across different types of accommodation facilities shows significant variability. In general, bed and breakfasts exhibit a more widespread digital presence, with a concentration in intermediate ranges. Traditional accommodation facilities, including scattered hotels and rural lodgings, typically incorporate digital technologies to a lesser extent. Hotels generally fall in between, showing a stable but moderate uptake of digital tools. Taken together, these insights point to the conclusion that digital transformation in the hospitality sector is determined by a combination of establishment type and managerial approach.

Table 2. *Frequency Distribution of the Digitalization Index by Accommodation Type*

	0.062	0.125	0.188	0.25	0.312	0.375	0.438	0.5	0.562	0.625	0.688	0.75
Bed and Breakfast	1	1	9	18	12	26	18	25	9	12	2	1
Farmhouse Stay	0	0	1	2	1	2	0	0	1	0	0	0
Guest House	10	6	6	5	6	4	7	5	3	1	0	0
Holiday Home	2	2	3	1	3	1	0	1	2	0	0	0
Hotel	0	0	1	0	1	2	5	6	9	2	0	0
Resort	0	0	0	0	0	0	0	1	1	0	0	0
Scattered Hotels	0	0	1	0	0	0	0	1	0	0	0	1
Tourist Residence	0	0	2	0	0	1	3	3	1	0	0	0

Source: Authors' own work

To assess the association between accommodation type and the level of digitalization—Cluster 1: digital contact variables; Cluster 2: presence on social media; and Cluster 3: presence on digital platforms (booking apps)—a chi-squared test was performed.

The results (Table 3) showed a statistically significant relationship between the two variables ($\chi^2 = 157.15$, df = 77, $p < 0.001$). This outcome implies that the extent of digitalization is influenced by the type of accommodation, highlighting possible variations in the implementation of digital technologies across the different categories examined.

Table 3. *Pearson's Chi-squared Test*

Test	χ^2	df	p-value	Significance
Pearson's Chi-squared test	157.15	77	1.97e-07	$p < 0.001$ (***)

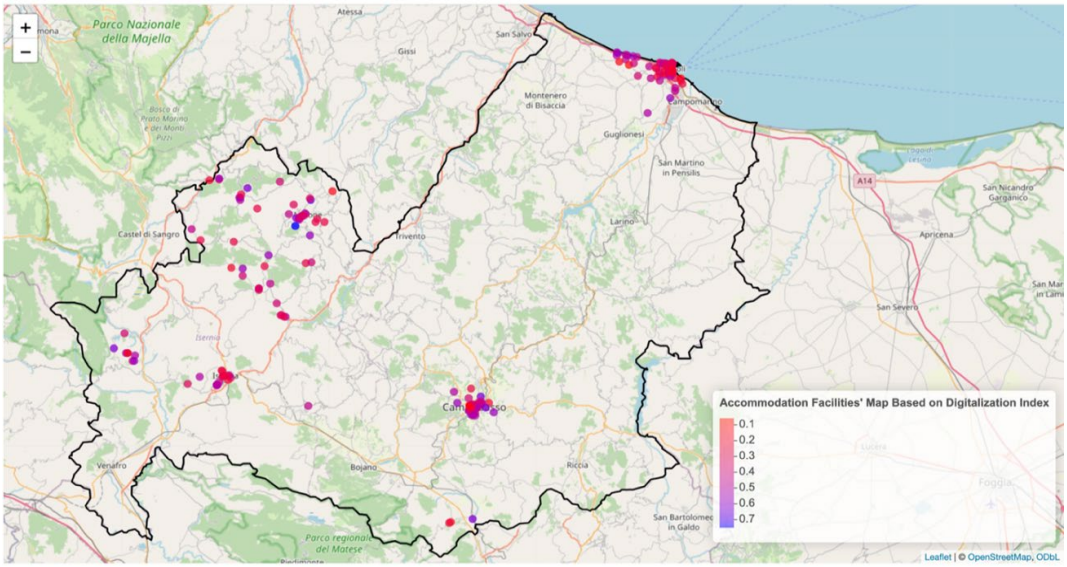
Source: Authors' own work

To measure the strength of the association, we calculated Cramér's V, which ranges from 0 (no association) to 1 (perfect association). We observed a value of 0.298, which is situated within the 0.2 to 0.4 range, signifying a moderate relationship between the type of accommodation and the level of digitalization. This finding implies that there is a correlation between these two factors, with the type of accommodation having an impact on the degree of digitalization.

Seismic Risk

In the subsequent phase of the analysis, we employed the geographical coordinates of the structure, specified in terms of latitude and longitude, to map the structures, including their levels of digitization. Employing R with the `leaflet` command, we developed an interactive map (see Figure 3).

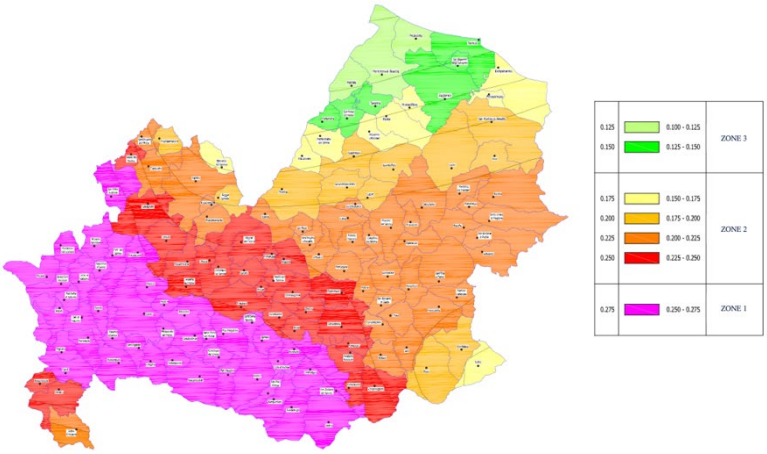
Figure 3. *Location of Accommodation Facilities in the Molise Region*



Source: Authors' own work

The Figure 3 presents a map detailing the locations of accommodation facilities across the Molise region, with each dot indicating a facility and its grade of digital advancement. A significant number of these facilities are clustered along the Adriatic coast, notably in the Termoli vicinity, as well as in inland areas that are popular with tourists, such as the mountainous zones and those close to the Majella National Park. The last step of the analysis is to assess which structures are most vulnerable to seismic risk. For this purpose, the seismic hazard map from the Molise region has been utilized (see Figure 4).

Figure 4. *Seismic Hazard Map of the Regional Territory*



Source: https://www.regione.molise.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/583, in the public domain.

The seismic hazard map for the Molise region delineates the division of the area into specific seismic areas, divided by the peak ground acceleration (PGA) experienced during earthquakes. This map classifies the region into three zones, each representing an escalating level of seismic risk.

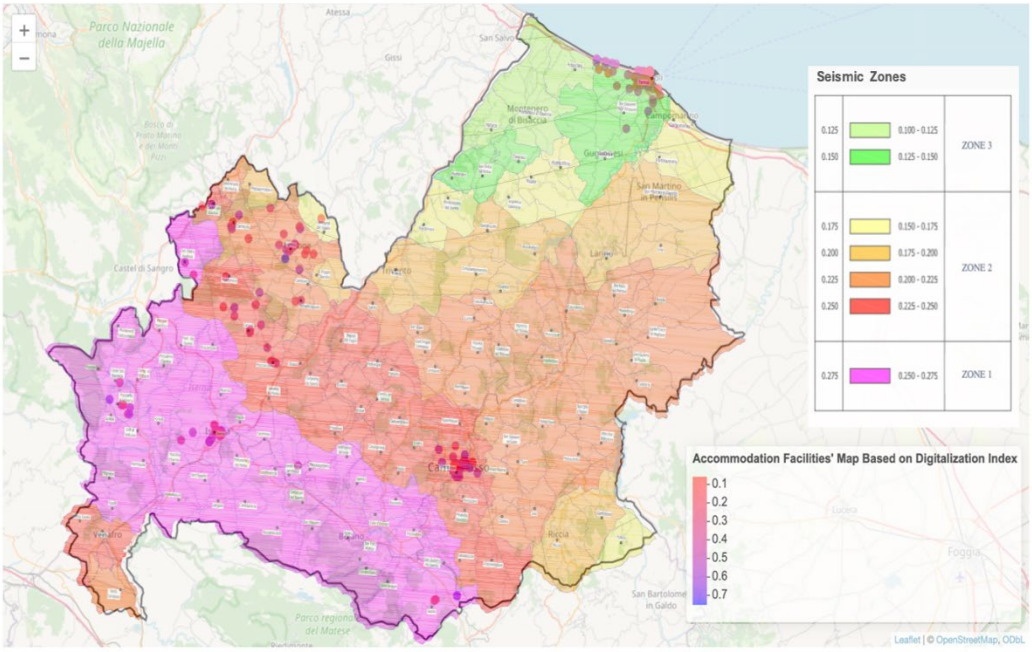
ZONE 3—Low Hazard, predominantly in municipalities in northern Molise.

ZONE 2—Medium Hazard, much of central and eastern Molise, including Campobasso and Isernia (with local variations). This is the zone with the greatest extent.

ZONE 1—High Seismic Hazard, an area with the highest expected acceleration in the event of an earthquake, thus the most prone to high seismic risk, present particularly in the southwestern and southeastern parts of Molise.

The analysis was completed by superimposing the two maps to determine which accommodation facility is most susceptible to seismic risk in the event of an earthquake (see Figure 5).

Figure 5. *Location of Accommodation Facilities according to Seismic Hazard*



Source: Authors' own work

In the southwestern region, characterized by high seismic hazard (zone 1), there is a significant presence of digitized structures, which are also well digitized. Conversely, the northern region of Molise, classified as zone 3 (low hazard), has a high concentration of buildings, some of which are highly digitized, though they are fewer than those in the south-central area. Campobasso, a city in zone 2, is characterized by a significant number of accommodations, many of which are extensively digitized.

Discussion

This study offers valuable insights into the relationship between digitalization and accommodation types in the Molise region, as well as their geographic distribution and exposure to seismic risk. The classification of facilities—ranging from B&Bs and guest houses to hotels, resorts, scattered hotels, and farmhouse stays—reveals a heterogeneous but moderately digitized hospitality sector.

The Normalized Digitalization Index shows a fairly uniform distribution, with all facilities positioned in the medium range and the central 50% of values spanning from 0.25 to 0.5. The lack of outliers indicates a uniform level of digital adoption throughout the region, supporting the notion that digitalization is becoming standard in tourism management, though there are notable variations among different types of accommodations. Bed and breakfasts, which constitute the majority of the sample—53.17%—display a wider range within medium to high digitalization levels. This implies that smaller, often owner-operated establishments are increasingly

embracing digital tools, likely motivated by the need to stay competitive, manage bookings effectively, and engage with customers online.

Guest houses follow a comparable trend. On the other hand, traditional accommodations such as scattered hotels and farmhouse stays often display lower levels of digitalization. This may be attributed to their focus on authenticity and local experiences, which might result in a reduced emphasis on incorporating technology.

Hotels show moderate but consistent digital adoption, likely influenced by established protocols and more structured management systems. The chi-squared test ($\chi^2 = 157.15$, df = 77, $p < 0.001$) confirms a statistically significant link between accommodation type and digitalization level.

A Cramér's V value of 0.298 indicates a moderate correlation, suggesting that the type of accommodation is among several factors impacting digitalization. Other crucial elements include the attitude of management, the availability of infrastructure, and competitive market positioning. Furthermore, spatial mapping enhances the understanding of regional accommodation service trends. High concentrations of accommodations are found along the Adriatic coast and in inland tourist areas, such as those near Majella National Park. These economically active zones tend to host more digitized facilities, indicating a correlation between tourism demand and digital investment. A crucial aspect of this research involved investigating the relationship between digitalization and seismic risk. By integrating the spatial layout of facilities with the seismic hazard map of the Molise region, the study discovered that many well-digitized buildings are located in high-risk areas (Zone 1), particularly in the southwestern part of the region.

Conversely, Zone 3 in the north, although rich in accommodation facilities, has fewer highly digitized establishments. Campobasso, located in Zone 2, shows a concentration of both accommodations and digital adoption, indicating the impact of urbanization and infrastructure. These results underscore the necessity of incorporating digitalization not only for operational efficiency and marketing but also as a part of risk management. In earthquake-prone areas, digital innovations such as early warning systems, real-time notifications, and emergency response platforms can bolster tourism infrastructure and enhance the safety of visitors. The digital transformation of the tourism industry in the Molise region is influenced by a variety of factors, including the types of accommodations, management strategies, geographic location, and exposure to risks, as well as the adoption of digital tools such as social media platforms and AI-based technologies (Di Virgilio and Das 2023a). By implementing policy measures and providing targeted support, particularly to traditional and high-risk businesses, a more balanced digital transformation can be promoted, thereby strengthening the sector's overall resilience.

Theoretical and Practical Implications

This study presents key theoretical insights, especially in terms of digital transformation and the use of large-scale social data. Digital technologies have transformed how supply and demand interact within the tourism industry, significantly affecting the visitor journey and overall experience. Existing theoretical

frameworks highlight the essential role of user-generated content and extensive social data in comprehending and managing the complex dynamics of tourism organizations. These data-driven strategies enable a deeper insight into tourist perceptions and behaviors, facilitating the co-creation of tourist experiences and enhancing the value provided to visitors (Cuomo et al. 2021). The perception of seismic risk among visitors and SMEs, along with the implications of technological progress, could be examined through the lens of risk communication and management. Tourists, who are typically unfamiliar with local hazards, often fail to recognize dangers, accentuating the significance of targeted communication strategies to raise awareness and readiness (Cisternas et al. 2024, Pahrudin et al. 2023).

The resilience of SMEs is increasingly being studied using the perspective of dynamic capabilities. In this context, resilience is viewed as a second-order dynamic capability that emerges when SMEs adjust their business models and use digital technology to deal with crises (Khurana et al. 2022). The concept of entrepreneurial resilience plays a pivotal role in current theoretical discussions on SME robustness. Scholars point to the importance of entrepreneurial initiative and informal business ecosystems in effectively addressing adversity, as opposed to the structured resilience systems commonly found in larger firms (Branicki et al. 2018). The integration of resilience with sustainability holds equal importance, promoting strategies for SMEs that enhance both organizational durability and contribute to societal welfare (DiBella et al. 2022). This approach is intricately connected to sustainable leadership frameworks, which stress the necessity of skill enhancement to ensure continuous resilient development (Suriyankietkaew et al. 2022).

In operational terms, digitalization acts as a driver for improvement in the tourism sector. In particular, AI is profoundly transforming the tourism SME sector, enhancing its innovation, efficiency, and competitiveness. AI promotes improved environmental, social, and governance (ESG) performance through the use of generative AI in digital value chains (Wang and Zhang 2025).

Moreover, AI enables more personalized strategies through big data, machine learning, and natural language (Filieri et al., 2021; Bulchand-Gidumal et al., 2023), while on the operational side it automates repetitive tasks, improves customer service (e.g., with chatbots), and enables the use of immersive technologies such as virtual reality (Samala et al. 2020). In addition, AI offers a competitive advantage to SMEs by enabling more informed decisions and personalized travel experiences (Stroumpoulis et al. 2022). From a policy perspective, the use of AI can also help to improve the moderate correlation between digitalization and the type of accommodation facility, as it enables the development of targeted support programs that encourage the technological advancement of less digitally developed establishments.

Further governments are encouraged to establish specialized programs aimed at bolstering tourist awareness and preparedness, with particular emphasis on international tourists who are less likely to perceive risks accurately. Public institutions and tourism boards could provide also financial incentives, or digital infrastructure improvements to help traditional accommodations, such as scattered hotels and farmhouse stays, enhance their digital presence while maintaining their distinctive characteristics. These efforts might include the dissemination of multilingual information and the installation of clear evacuation routes (Cisternas et al. 2024).

For SMEs, digital solutions provide essential support in managing emergency communication and increasing preparedness. A diverse array of digital instruments facilitates earthquake preparedness by delivering real-time information and improving behavioral readiness. Advanced systems such as Digital Twin (Yu et al. 2023), IoT and cloud computing (Cheng et al. 2021), alternative communication channels (Parlar et al. 2024, Centelles et al. 2021), and machine learning solutions (Abdalzaher et al. 2023) enhance resilience in urban areas with high seismic risk. Utilizing these platforms facilitates stakeholder coordination and contributes to business resilience in the aftermath of seismic events (Pahrudin et al. 2023). Urban development strategies should now prioritize innovative risk management methodologies. The use of digital technologies, including remote sensing, enhances the capacity to assess and mitigate risks, forming a foundation for resilient urban infrastructures (An and Zhang 2022).

The adoption of digital transformation enhances the ability of SMEs to navigate disruptions with agility, safeguarding their market position in increasingly unpredictable economies (Khurana et al. 2022, Awad and Martín-Rojas 2023). Incorporating corporate social responsibility into organizational strategy represents an additional mechanism to foster resilience, promoting long-term sustainability within SME ecosystems (Awad and Martín-Rojas 2023). Finally, resilience is also enhanced through community involvement. SMEs are encouraged to implement approaches that support not only their own operations but also contribute to the wider community's adaptive capacity (DiBella et al. 2022).

While efforts were made to connect the theoretical insights with practical relevance, it is important to note that, to the best of our knowledge, there are currently no real-world case studies or prior research that explicitly examine the relationship between digitalization in the tourism sector and seismic risk classification. This lack of precedent highlights the innovative character of our study and limits the possibility of direct comparison with other regions or industries at this stage. Nevertheless, the framework developed here offers a foundation that can be adapted and applied in other risk-prone contexts. In this sense, it provides practitioners and policymakers with a starting point to explore how digital strategies might interact with environmental vulnerability in tourism planning and management.

In the specific context of Molise, the theoretical frameworks of entrepreneurial resilience and dynamic capabilities gain concrete relevance due to the region's dual challenges: a structurally fragile tourism ecosystem and a high seismic risk classification. Molise is characterized by a prevalence of micro and small tourism enterprises, often operating in geographically dispersed or rural areas with limited access to digital infrastructure. These SMEs must simultaneously deal with low digital maturity and the uncertainty posed by natural hazards. Within this environment, dynamic capabilities—such as sensing risks, seizing digital opportunities, and reconfiguring business processes—become critical for survival and adaptation. For instance, the ability to adopt digital tools for emergency communication, or to pivot toward online customer engagement during periods of post-seismic recovery, represents a concrete manifestation of these capabilities. Likewise, entrepreneurial resilience in Molise can be observed in informal, community-based networks and local partnerships that help sustain tourism activities despite infrastructural fragility. This illustrates how abstract theoretical constructs materialize in territories with high environmental

vulnerability and limited economic diversification, providing important lessons for similarly exposed regions.

Conclusion and Future Research

This study has explored the multifaceted relationship between digitalization, accommodation typologies, and seismic risk exposure in the Molise region. The findings reveal that while digital adoption is increasingly widespread across the tourism sector, its intensity and scope vary significantly based on structural characteristics, managerial strategies, and geographic location. In particular, areas that are both physically and digitally marginalized—such as mountainous and seismically active zones—face compounded vulnerabilities that can be partially addressed through targeted digital interventions.

Digital technologies, including AI-powered chatbots and mobile applications, play a critical role in enhancing both competitiveness and resilience. Chatbots can improve customer service by offering continuous, personalized assistance, reducing response times, and increasing guest satisfaction and loyalty (Yun and Park 2022, Melián-González et al. 2021, Pereira et al. 2022). Likewise, mobile platforms offer real-time updates on local hazards, emergency procedures, and safety guidelines, thereby strengthening tourists' preparedness while respecting privacy concerns (Lei et al. 2022).

Moreover, digital tools can serve as effective channels for disseminating essential information, especially in regions prone to natural disasters. Providing multilingual safety content, clear evacuation routes, and culturally sensitive communication can enhance seismic awareness among international visitors, a particularly vulnerable group in emergency scenarios (Cisternas et al. 2024).

Ultimately, this study highlights digitalization not merely as a driver of operational efficiency but as a strategic enabler of sustainable and risk-informed tourism development. It offers a foundational basis for public and private stakeholders to formulate digital strategies that are responsive to both internal business models and external environmental threats.

Future research should examine the evolution of digital adoption in the tourism sector over time, considering technological, environmental, and regulatory changes. In particular, longitudinal studies could provide valuable insights into the potential of digital tools to improve resilience and competitiveness, particularly in seismically vulnerable regions. The abilities, constraints, and motivations of accommodation administrators could be revealed through qualitative investigations into their perspectives.

The comprehension of visitors' satisfaction and their sense of safety can be aided by examining interaction and perception with respect to digital safety tools, especially in contexts characterized by high seismic risk. Comparative studies could be conducted in regions with high tourist influx and different risk profiles-such as Italy and other countries subject to increasingly frequent natural events—and could offer scalable models of digital resilience and best practices. Such an approach has the potential to strengthen the development of tourism ecosystems that are more integrated, adaptable, and capable of responding effectively to crises.

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