

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

*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 & Montini, 2001). Moreover, tourists' risk perceptions significantly influence their travel choices, directly affecting the competitiveness of these locations (Akamavi et al., 2023; Scott & 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 & Ghaffarian, 2024; Ye et al., 2022). Concurrently, analytics and Artificial Intelligence (AI) technologies assist small and 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

1 destinations but also helps in gathering essential feedback for service  
2 enhancement (Sharma & Sharma, 2024; Di Virgilio, 2022).

3 This research explores the following question:  
4

5 RQ1: Does digitalization contribute to mitigating the effects of seismic risk  
6 on tourism and promoting the resilience of tourist destinations?  
7

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

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

### 29 *Digitalization of SMEs in the Tourism Sector*

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31  
32 Embracing digital technologies is essential for enhancing the  
33 competitiveness and ensuring the sustainable development of the tourism sector.  
34 Employing new technologies such as AI, virtual reality, and big data enables  
35 firms to enhance service quality, optimize business operations, and foster  
36 innovation, so ensuring a sustainable competitive advantage in the market (Chen,  
37 2024; Mick et al., 2024). The adoption of Information and Communication  
38 Technologies (ICT) has transformed market dynamics and management  
39 approaches, making it easier and more flexible for tourism SMEs to  
40 commercialize their offerings (Lara et al., 2017). Beyond operational  
41 enhancements, digitalization bolsters the sector's resilience by lessening the  
42 impact of crises—such as those triggered by the COVID-19 pandemic—through  
43 increased tourism consumption and fiscal support (Tang, 2024). Moreover, the  
44 adoption of digital tools is essential for sustaining corporate stability and  
45 assuring long-term viability (Surya et al., 2022). Digital transformation  
46 encompasses an array of technologies, including artificial intelligence, such as

1 DeepSeek and chatbots; virtual reality; augmented reality; big data; and the  
2 Internet of Things (IoT), which enhance efficiency and revolutionize customer  
3 experiences through personalization and improved resource management  
4 (Kindzule-Millere & Zeverte-Rivza, 2022; Jha, 2024). The development and  
5 implementation of virtual experiences—initially accelerated by the restrictions  
6 imposed during the COVID-19 pandemic—underscore their potential not only  
7 as a temporary response, but also as a long-term integrative component,  
8 especially when supported by the strategic use of AI tools (Amarendra & Das,  
9 2022). Mobile applications like DepApp (Kırcı et al., 2023) and web platforms  
10 (Verrucci et al., 2016) provide real-time information and practical guidance for  
11 earthquake response. Immersive tools, such as virtual reality and serious games  
12 (Feng et al., 2020), improve behavioral preparedness, while advanced  
13 technologies like Digital Twin (Yu et al., 2023), cloud computing, and IoT  
14 (Cheng et al., 2021) facilitate simulation and emergency coordination.  
15 Alternative communication systems (Parlar et al., 2024; Centelles et al., 2021),  
16 peer-to-peer applications (Han et al., 2016), and machine learning-based  
17 solutions (Abdalzاهر et al., 2023) are also noteworthy. Key domains, such as  
18 social media and mobile booking applications, significantly influence consumer  
19 decisions and necessitate organizational adaptation (Paul et al., 2024). The use  
20 of video material on social media platforms such as Facebook, Flickr, Instagram,  
21 LinkedIn, Pinterest, Twitter, and YouTube is widely recognized as a pivotal  
22 strategic asset for the tourism sector. This method enhances and promotes places  
23 engagingly, strengthens emotional connections with visitors, and creates new  
24 economic opportunities (Di Virgilio & Das, 2023a). Social media should not be  
25 viewed solely as communication tools; instead, they must be acknowledged as  
26 strategic marketing platforms capable of influencing the behavioral decisions of  
27 other customers through user interactions (Di Virgilio et al., 2017). A social  
28 media campaign may aim to enhance customer loyalty, a goal made more  
29 complex by the difficulty of precisely assessing users' emotions and sentiments  
30 (Di Virgilio et al., 2024). The amalgamation of social media-driven service  
31 innovation and mobile booking applications augments sustainable development  
32 in the tourism and hospitality sector by enhancing service quality, minimizing  
33 environmental impact, and promoting sustainable leadership (Zada et al., 2025;  
34 Polukhina et al., 2025). Digital booking systems and social media engagement  
35 enhance travel experiences by making them more immersive and interconnected  
36 while also promoting sustainable tourism through improved accessibility and  
37 innovative services (Tandafatu et al., 2024; Zada et al., 2025). The concepts of  
38 Tourism 4.0 and smart tourism destinations focus on minimizing tourism's  
39 environmental impact and encouraging sustainable practices by utilizing digital  
40 technologies to offer highly personalized and engaging experiences for tourists  
41 (Pencarelli, 2019; Kindzule-Millere & Zeverte-Rivza, 2022). Studies indicate  
42 that digital tools can significantly boost rural tourism income, especially when  
43 tailored to the unique characteristics of natural and cultural landscapes (Zhang  
44 et al., 2025; Alonso et al., 2024). The use of digital platforms for booking and  
45 information dissemination has improved the efficiency and sustainability of

1 tourism services, reducing environmental impacts and increasing resource  
2 availability (Polukhina et al., 2025).

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

### 9 10 *Seismic Risk in Tourism*

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12 Seismic risk, which refers to the likelihood of surpassing a certain impact  
13 level due to earthquakes, poses a major threat to tourism by causing physical  
14 damage, economic losses, and social disruption (Brillinger, 1982; Carreño et al.,  
15 2007; Carreño et al., 2011; Jena et al., 2020; Akamavi et al., 2023). SMEs,  
16 particularly micro-businesses, face difficulties in disaster preparedness due to  
17 financial barriers and restricted access to resilience tools (Orchiston, 2012;  
18 Orchiston, 2013). Earthquakes pose major threats to infrastructure, disrupting  
19 transportation, food supply networks, and accommodation services,  
20 underscoring the importance of robust seismic risk management strategies  
21 (Orchiston, 2012; Mäntyniemi, 2012). A key component of risk mitigation is  
22 seismic risk assessment, which evaluates the probability and impact of  
23 earthquakes on tourism infrastructure to improve preparedness (Hosseinpour et  
24 al., 2021). Effective communication of seismic risks to crisis management teams,  
25 particularly in tourists' home countries, ensures that at-risk travel destinations  
26 are properly assessed (Mäntyniemi, 2012). The role of digitalization in  
27 enhancing SMEs' resilience in earthquake-prone areas is vital, especially in  
28 developing nations. Research on SMEs in Aceh, Indonesia, demonstrates how  
29 digital technologies, such as cloud computing and e-commerce, support risk  
30 management by ensuring business continuity and adaptability during seismic  
31 events (Chan et al., 2023).

32 Lessons drawn from past crises, such as the COVID-19 pandemic,  
33 emphasize that innovation and adaptability are essential for effectively  
34 managing external disruptions, providing important guidance for seismic risk  
35 readiness (Rastegar et al., 2023). Moreover, how tourists perceive seismic risk  
36 significantly impacts their travel choices, directly affecting the competitiveness  
37 of various destinations (Akamavi et al., 2023). Risk perception is a key element  
38 of tourist behavior, affecting how travelers evaluate destinations and make travel  
39 decisions. When perceived risk is high, it can decrease the impact of positive  
40 destination image and motivation on intention to travel (Caber et al., 2020).  
41 Despite perceived risks, tourists persist in revisiting and endorsing destinations,  
42 especially when environmental concerns are not viewed as major impediments  
43 (Setiawan et al., 2024). In earthquake-prone regions, the tourism sector  
44 prioritizes digitalization and the rebuilding of trust. The central goal is to deliver  
45 a secure, dependable, and high-quality experience to visitors by leveraging

1 advanced technologies and protocols that emphasize personal safety (Di Virgilio  
2 & Das, 2023b).

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

21 Mobile platforms are fundamental in improving visitors' readiness by  
22 offering real-time information on risks and safety protocols while ensuring  
23 privacy (Aliperti & Cruz, 2020; Psaroudakis et al., 2021). These instruments are  
24 necessary for efficient risk management and emergency response, especially for  
25 natural catastrophes and pandemics. Nevertheless, enhancing user awareness  
26 and adoption continues to pose a barrier that necessitates focus (Aliperti & Cruz,  
27 2020).

### 28 29 *Resilience in Supporting SMEs*

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31 Resilience is vital for the longevity of tourism SMEs, allowing them to face  
32 crises and recover efficiently. Essential resilience factors include supply chain  
33 collaboration, strategic HR management, and adaptability (Seow et al., 2024).  
34 SMEs that emphasize innovation, product development, and technology  
35 integration demonstrate higher crisis adaptability (Sepúlveda & Bustamante-  
36 Caballero, 2024). Entrepreneurial connections and a proactive approach to risk  
37 also contribute to resilience by encouraging adaptation (Dias et al., 2022).  
38 Leadership, employee training, and internal management methods are crucial for  
39 maintaining business continuity (Núñez-Ríos et al., 2022). Digital  
40 transformation, including virtual reality, allows SMEs to maintain business  
41 operations and expand their market reach during crises (Sánchez & Palos-  
42 Sánchez, 2020; Sepúlveda & Bustamante-Caballero, 2023). Additionally,  
43 governance, stakeholder engagement, and risk assessments play vital roles in  
44 reinforcing resilience and improving tourism performance (Caluza, 2024).  
45 Strong community ties also support SMEs during crises by providing additional  
46 resources and assistance (Dahles & Susilowati, 2015; Dias et al., 2022).

## 1 Methodology

### 2 3 *Data Collection and Sample*

4  
5 This study is based on a secondary analysis of data gathered from two  
6 principal sources: Confartigianato and the Molise Region. The initial dataset  
7 offers comprehensive information on 252 accommodation SMEs in Molise,  
8 encompassing 20 variables that reflect both quantitative and qualitative  
9 variables.

10 The quantitative variables were divided into 6 clusters. Digital contact  
11 variables (Cluster 1) include the presence of an email, a landline phone number,  
12 a mobile number, and a website. Cluster 2 concerns the presence of the structure  
13 on social media, considering platforms such as Facebook, Flickr, Instagram,  
14 LinkedIn, Pinterest, Twitter, and YouTube. Cluster 3 includes the presence on  
15 digital platforms (booking apps), such as TripAdvisor, Booking, Hotels.com,  
16 Airbnb, and Trivago. In addition, the dataset contains the geographical  
17 coordinates of the structure (Cluster 4), expressed in latitude and longitude, and  
18 two qualitative variables: the type of structure (Cluster 5), which distinguishes  
19 between Bed and Breakfast, Farmhouse Stay, Guesthouse, Holiday Home,  
20 Hotel, Resort, Scattered Hotel and Tourist Residence, and the municipality of  
21 residence, recorded as a textual variable (Cluster 6).

22  
23 **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 & 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 & 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 & 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 frequently 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 & 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).

1 *Source: Authors' own work*

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

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

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

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

### 7 *Data analysis*

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

## 19 20 21 **Results**

### 22 23 *Distribution*

24  
25 There were 252 accommodation facilities; among them, 0.79% were resorts,  
26 1.19% were scattered hotels, 2.78% were farmhouses, 3.97% were tourist  
27 residences, 5.95% were holiday homes, 10.32% were hotels, 21.83% were guest  
28 houses, and 53.17% were bed and breakfasts.

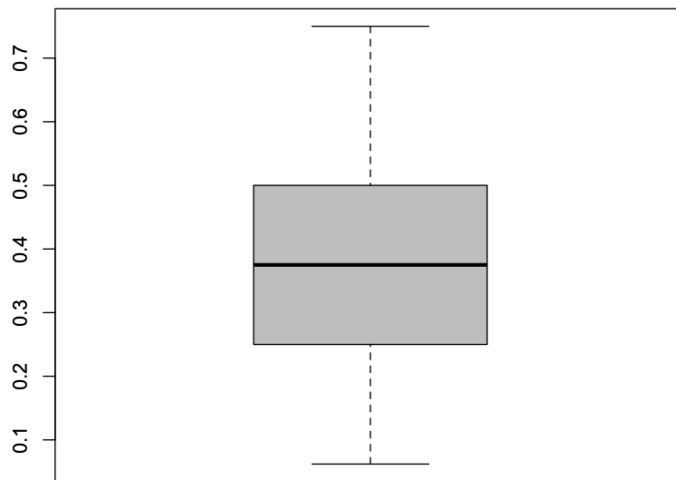
### 29 30 *Measurement Model*

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

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1 **Figure 1.** *Box Plot of Digitalization Index*



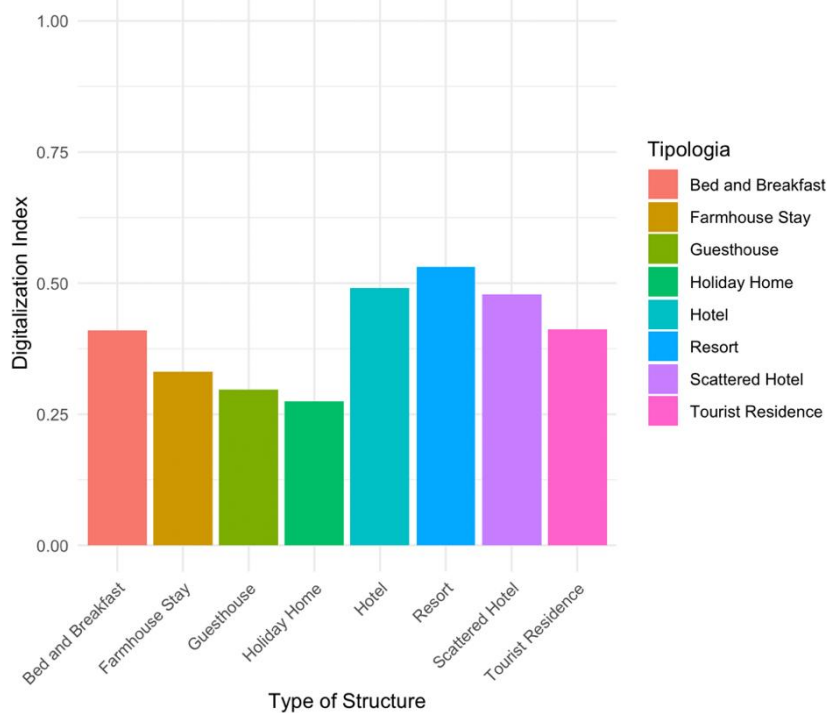
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Source: Authors' own work

5 The box, which represents the interval from the first quartile ( $Q1 \approx 0.25$ ) to  
6 the third quartile ( $Q3 \approx 0.5$ ), shows that the central 50% of establishments have  
7 digitalization levels between 0.25 and 0.5. The digitalization level of the  
8 accommodations in the dataset is generally moderate, with a concentration in the  
9 0.25–0.5 range. Analyzing the average digitalization level for each type of  
10 establishment was beneficial, as it offered insights into how various  
11 accommodation categories have adopted digital tools and technologies (see  
12 Figure 2).

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



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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*

	0.06 2	0.12 5	0.18 8	0.2 5	0.31 2	0.37 5	0.43 8	0.5 5	0.56 2	0.62 5	0.68 8	0.7 5
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.

To verify the existence of an association between the type of accommodation and the level of digitalization, a chi-squared test was conducted.

The results (Table 2) showed a statistically significant relationship between the two variables ( $\chi^2 = 157.15$ ,  $df = 77$ ,  $p < 0.001$ ). The findings lead us to reject the null hypothesis ( $H_0$ ) in favor of the alternative hypothesis ( $H_1$ ). 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.

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

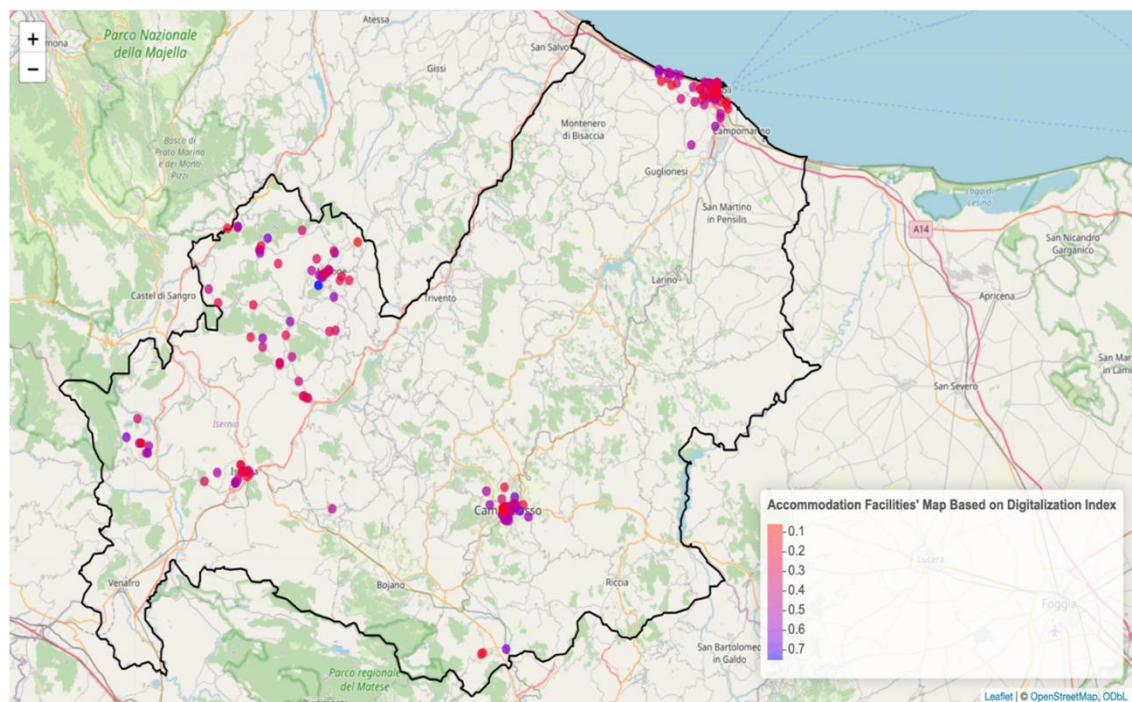
Test	$\chi^2$	df	p-value	Significance
Pearson's Chi-squared test	157.15	77	1.97e-07	p < 0.001 (***)

2 *Source: Authors' own work*

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4 To measure the strength of the association, we calculated Cramér's V, which  
5 ranges from 0 (no association) to 1 (perfect association). We observed a value of  
6 0.298, which is situated within the 0.2 to 0.4 range, signifying a moderate  
7 relationship between the type of accommodation and the level of digitalization.  
8 This finding implies that there is a correlation between these two factors, with  
9 the type of accommodation having an impact on the degree of digitalization.

10 *Seismic risk*

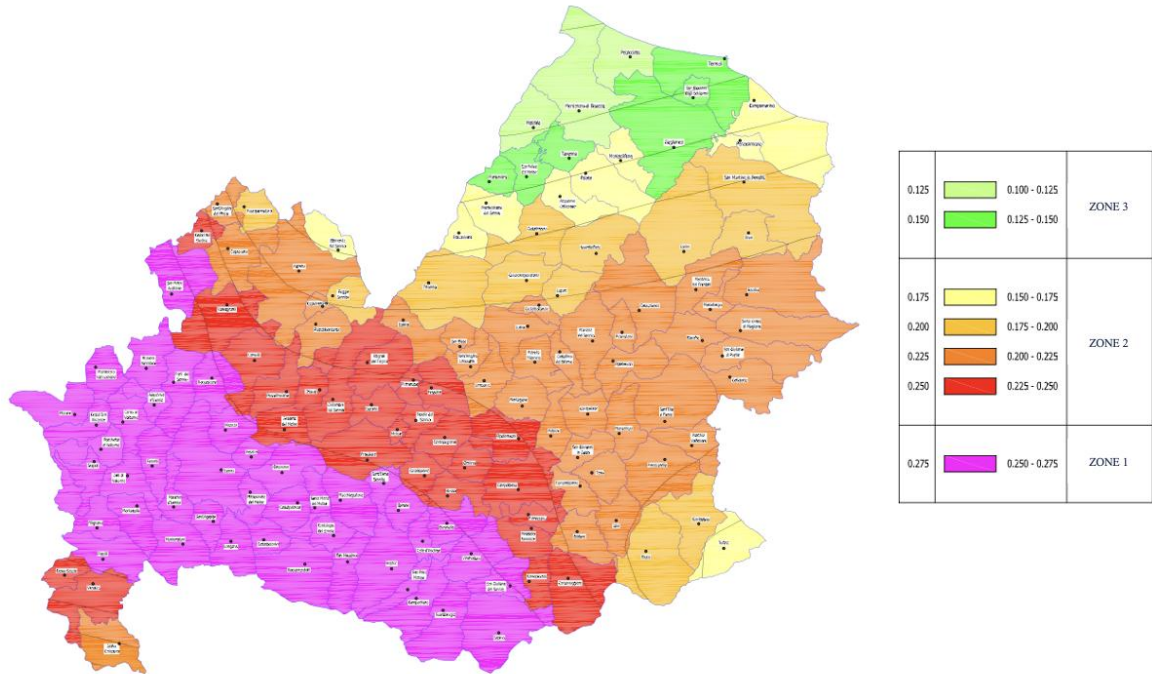
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13 In the subsequent phase of the analysis, we employed the geographical  
14 coordinates of the structure, specified in terms of latitude and longitude, to map  
15 the structures, including their levels of digitization. Employing R with the  
16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

17 **Figure 3. Location of Accommodation Facilities in the Molise Region**18 *Source: Authors' own work*

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22 The Figure 3 presents a map detailing the locations of accommodation  
23 facilities across the Molise region, with each dot indicating a facility and its  
24 grade of digital advancement. A significant number of these facilities are  
25 clustered along the Adriatic coast, notably in the Termoli vicinity, as well as in

1 inland areas that are popular with tourists, such as the mountainous zones and  
 2 those close to the Majella National Park. The last step of the analysis is to assess  
 3 which structures are most vulnerable to seismic risk. For this purpose, the  
 4 seismic hazard map from the Molise region has been utilized (see Figure 4).  
 5

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



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

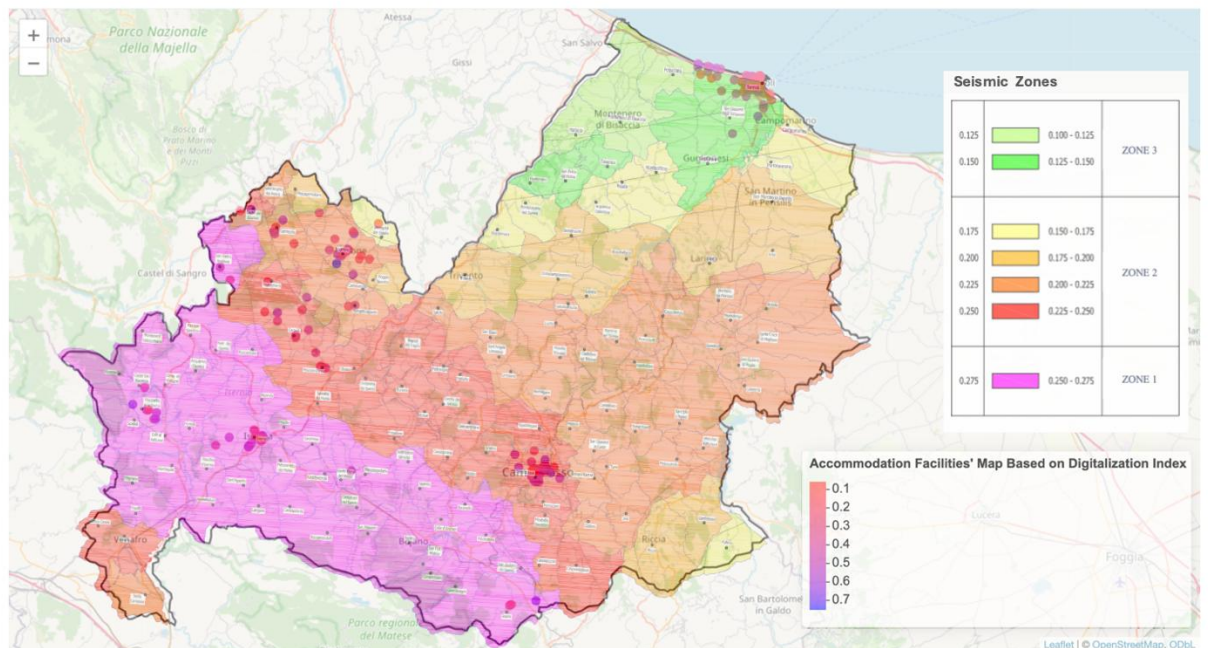
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 11 The seismic hazard map for the Molise region delineates the division of the  
 12 area into specific seismic areas, divided by the peak ground acceleration (PGA)  
 13 experienced during earthquakes. This map classifies the region into three zones,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

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

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

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

22 The analysis was completed by superimposing the two maps to determine  
 23 which accommodation facility is most susceptible to seismic risk in the event of  
 24 an earthquake (see Figure 5).  
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1 **Figure 5.** *Location of Accommodation Facilities According to Seismic Hazard*

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3 Source: Authors' own work

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

## 12 13 14 Discussion

15  
16 This study offers valuable insights into the relationship between  
17 digitalization and accommodation types in the Molise region, as well as their  
18 geographic distribution and exposure to seismic risk. The classification of  
19 facilities—ranging from B&Bs and guest houses to hotels, resorts, scattered  
20 hotels, and farmhouse stays—reveals a heterogeneous but moderately digitized  
21 hospitality sector.

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

1 establishments are increasingly embracing digital tools, likely motivated by the  
2 need to stay competitive, manage bookings effectively, and engage with  
3 customers online.

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

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

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

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

43  
44  
45

## 1 **Theoretical and Practical Implications**

2  
3 This study presents key theoretical insights, especially in terms of digital  
4 transformation and the use of large-scale social data. Digital technologies have  
5 transformed how supply and demand interact within the tourism industry,  
6 significantly affecting the visitor journey and overall experience. Existing  
7 theoretical frameworks highlight the essential role of user-generated content and  
8 extensive social data in comprehending and managing the complex dynamics of  
9 tourism organizations. These data-driven strategies enable a deeper insight into  
10 tourist perceptions and behaviors, facilitating the co-creation of tourist  
11 experiences and enhancing the value provided to visitors (Cuomo et al., 2021).  
12 The perception of seismic risk among visitors and SMEs, along with the  
13 implications of technological progress, could be examined through the lens of  
14 risk communication and management. Tourists, who are typically unfamiliar  
15 with local hazards, often fail to recognize dangers, accentuating the significance  
16 of targeted communication strategies to raise awareness and readiness (Cisternas  
17 et al., 2024; Pahrudin et al., 2023).

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

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

37 Moreover, AI enables more personalized strategies through big data,  
38 machine learning, and natural language (Filieri et al., 2021; Bulchand-Gidumal  
39 et al., 2023), while on the operational side it automates repetitive tasks, improves  
40 customer service (e.g., with chatbots), and enables the use of immersive  
41 technologies such as virtual reality (Samala et al., 2020). In addition, AI offers a  
42 competitive advantage to SMEs by enabling more informed decisions and  
43 personalized travel experiences (Stroumpoulis et al., 2022). From a policy  
44 perspective, the use of AI can also help to improve the moderate correlation  
45 between digitalization and the type of accommodation facility, as it enables the

1 development of targeted support programs that encourage the technological  
2 advancement of less digitally developed establishments.

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

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

26 The adoption of digital transformation enhances the ability of SMEs to  
27 navigate disruptions with agility, safeguarding their market position in  
28 increasingly unpredictable economies (Khurana et al., 2022; Awad & Martín-  
29 Rojas, 2023). Incorporating corporate social responsibility into organizational  
30 strategy represents an additional mechanism to foster resilience, promoting long-  
31 term sustainability within SME ecosystems (Awad & Martín-Rojas, 2023).  
32 Finally, resilience is also enhanced through community involvement. SMEs are  
33 encouraged to implement approaches that support not only their own operations  
34 but also contribute to the wider community's adaptive capacity (DiBella et al.,  
35 2022).

## 36 37 38 **Conclusion and Future Research**

39  
40 This study has explored the multifaceted relationship between digitalization,  
41 accommodation typologies, and seismic risk exposure in the Molise region. The  
42 findings reveal that while digital adoption is increasingly widespread across the  
43 tourism sector, its intensity and scope vary significantly based on structural  
44 characteristics, managerial strategies, and geographic location. In particular,  
45 areas that are both physically and digitally marginalized—such as mountainous



1 and seismically active zones—face compounded vulnerabilities that can be  
2 partially addressed through targeted digital interventions.

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

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

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

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

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

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