



Social Innovation in Disaster-Prone Areas: Developing Resilient Tourism Villages in the Slopes of Mount Merapi, Sleman

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ABSTRACT

Purpose – This study investigates how social innovation contributes to the development of resilient tourism villages in the disaster-prone areas of Sleman Regency, Yogyakarta, particularly on the slopes of Mount Merapi. The research addresses the challenge of building sustainable local economies while enhancing disaster preparedness and community resilience.

Design/methods/approach – A qualitative case study approach was employed in three selected tourism villages: Pentingsari, Glagaharjo, and Umbulharjo. Data were collected through in-depth interviews with community leaders and government officials, focus group discussions with residents, field observations, and policy document analysis. Thematic analysis was supported by NVivo 12 Plus software to identify patterns of innovation and stakeholder engagement.

Findings – The study reveals that social innovation in these villages is driven by multi-stakeholder collaboration, particularly through Pentahelix interactions involving government, academia, private sector, community, and media. Innovations include disaster education-based tourism, digital marketing of local products, and integration of local wisdom in tourism offerings. These strategies enhance both economic benefits and community preparedness.

Research implications/limitations – The study is limited to three case villages with strong local leadership, which may not reflect conditions in less organized communities. Findings may be less applicable in regions lacking external support from NGOs or academic institutions.

Originality/value – This study highlights the strategic role of social innovation in transforming disaster-prone areas into resilient and economically vibrant tourism villages. It provides practical insights for policymakers and development practitioners seeking to foster community-based disaster resilience through tourism.

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Introduction

Tourism development in rural and disaster-prone areas, such as the slopes of Mount Merapi in Sleman Regency, Yogyakarta, serves as a strategic approach to community empowerment and sustainable development, primarily through fostering social innovation and resilience. The integration of tourism in these areas is not merely an economic opportunity but acts as a catalyst for social transformation and resilience building. Tourism can amplify

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community adaptive capacities by leveraging local resources, enhancing economic stability, and fostering social cohesion. Resilience is crucial in the face of environmental and socio-economic shocks, necessitating a comprehensive strategic framework for sustainable tourism development.

Various studies underscore the critical intersection of tourism, disaster risk, and community innovation. Liu-Lastres et al. (2020) highlight the role of post-disaster tourism in improving local livelihoods, suggesting that strategic tourism development can enhance community resilience. This aligns with findings from Rindrasih (2018), which demonstrate that tourism activities in volcanic regions can bolster community resilience through collective action and adaptation to shocks. Furthermore, Yang and Kim's research (2023) posits that community resilience enhances host communities' abilities to respond to disasters, positively influencing tourism sustainability and local quality of life. The model of disaster-resilient villages articulated by Arifin et al. (2021) stresses the importance of decentralized disaster management, complementing tourism development initiatives aimed at community empowerment. Additionally, studies by Lew et al. (2017) and Ibănescu et al. (2020) examine how community-based tourism can evolve adaptive strategies that enhance resilience against disasters, contingent upon favorable economic conditions and accessibility. Moreover, the literature asserts that social innovation is pivotal for developing sustainable tourism frameworks, as demonstrated by Castro-Spila et al. (2018), who explored the importance of community-driven innovations in tourism settings. In conclusion, the development of tourism in disaster-prone rural areas like Sleman Regency is integral to achieving sustainable community empowerment by fostering resilience and social innovation. The existing literature provides strong evidence that strategic tourism practices can withstand environmental challenges while nurturing socio-economic stability and community cohesion, ultimately leading to sustainable development outcomes.

Mount Merapi, as one of Indonesia's most active volcanoes, presents significant challenges to surrounding communities. However, neighboring villages, including Pentingsari, Glagaharjo, and Umbulharjo, have adopted tourism as a strategy for livelihood diversification, cultural preservation, and community revitalization. The recurring volcanic activity poses various risks, yet these communities have successfully transformed their vulnerabilities into adaptive strengths through innovative practices. By developing tourism-related initiatives, they not only generate economic opportunities but also foster social cohesion, environmental awareness, and disaster preparedness, enhancing their overall resilience against natural disasters. Research indicates that tourism can significantly contribute to community recovery in disaster-prone areas. For instance, Tobirin et al. (2024) discuss

how disaster-prone villages can evolve into socioeconomic hubs through strategic tourism initiatives, thereby acting as safety nets for community engagement and environmental conservation. Additionally, Zhang et al. (2023) emphasize that the development of post-disaster tourism assists communities in generating revenue and supports local economies after disasters. Nurjanah et al. (2023) examine the essential role of stakeholder involvement in enhancing disaster awareness and safety in tourist areas, demonstrating how effective communication and engagement can improve tourism practices and public readiness for natural disasters.

Moreover, Krisanti et al. (2024) investigate community-based land use models in the Merapi disaster zone, highlighting that strategic planning optimizes tourism benefits while minimizing risks tied to volcanic eruptions. This is consistent with the findings of Liu-Lastres et al. (2020), who explore how post-disaster tourism development contributes to community resilience by enhancing social capital and local agency. In conclusion, despite the volcanic hazards posed by Mount Merapi, the adaptive strategies employed by adjacent villages illustrate a promising pathway for community empowerment through tourism. By actively engaging in tourism development, these communities enhance their economic foundations and cultivate a resilient socio-cultural framework necessary for thriving amid environmental adversity. Further research could explore the role of social innovation in optimizing these frameworks for sustainable community development in disaster-prone regions.

This study is motivated by the need to understand how bottom-up, community-led innovations interact with top-down institutional frameworks to co-produce tourism-based resilience in hazard-prone settings. It contributes to the body of knowledge on social innovation by examining its application in a non-urban, disaster-sensitive, and culturally rich environment. Furthermore, the study aligns with the growing scholarly emphasis on multi-stakeholder collaboration, participatory development, and locally grounded sustainability models in tourism and disaster risk reduction.

The Importance of the Topic

The significance of this research is highlighted by its alignment with multiple overlapping global agendas, including the Sendai Framework for Disaster Risk Reduction (2015–2030), the Sustainable Development Goals (SDGs), and the principles of community-based tourism (CBT), particularly concerning the resilience and sustainability of communities situated near Mount Merapi. These frameworks underscore the importance of integrating disaster risk reduction strategies and sustainable development principles with community engagement to foster resilience. Specifically, SDG 11 addresses the essential aim of creating inclusive, safe, resilient, and

sustainable urban and rural communities. This goal resonates particularly well with the challenges faced by communities on the slopes of Mount Merapi, where both disaster preparedness and sustainable tourism practices are vital for local livelihoods.

A study by Silva et al. Silva et al. (2024) discusses how tourism can serve as a crucial vehicle for achieving the SDGs, emphasizing its role in creating employment opportunities and promoting sustainable development initiatives. The authors argue that community-based tourism (CBT) aligns closely with SDG objectives by empowering local populations and ensuring that the benefits of tourism contribute to broad-based community well-being. Moreover, Bournalon et al. Bournalon et al. (2021) demonstrate the importance of supporting local community involvement in developing sustainable tourism practices, which can facilitate disaster preparedness and enhance resilience through informed local action.

Research by Dax et al. Dax et al. (2019) supports the notion that recognizing and integrating local cultural and natural heritage into tourism initiatives enhances both economic viability and community identity while promoting sustainable practices that align with disaster management efforts. Implementing community-driven tourism models can transform vulnerabilities into strengths, allowing communities around Mount Merapi to leverage tourism in ways that sustain their livelihoods and fortify their capacity to adapt to and recover from environmental shocks. Additionally, contributions from Saarinen Saarinen (2020) highlight the critical relationship between tourism and sustainable development on a global scale. This underscores the necessity for effective disaster risk management strategies that are interwoven with sustainable tourism goals, accentuating the need for policies that contribute to safer and more resilient communities.

This research is significant because it contextualizes the importance of the Sendai Framework, the Sustainable Development Goals, and community-based tourism principles in addressing the needs of communities near Mount Merapi. The findings support the view that tourism can play a pivotal role in fostering resilience and sustainability, proving vital in the face of natural disasters. Continued exploration of these intersections will enhance future policy development and community empowerment efforts in disaster-prone regions.

The evolving perception of tourism as a vehicle for empowerment and ecological conservation underscores its potential to drive sustainable practices, particularly in disaster-prone areas where community resilience is paramount. Traditionally, tourism has been critiqued for contributing to environmental degradation and socio-cultural commodification. However, when planned and executed collaboratively with local communities, tourism can serve not only as a source of income but also as a critical tool for risk

awareness, preparedness, and enhanced adaptive capacity to climate and natural disaster risks. This collaborative approach reflects a broader trend in development thinking, emphasizing local knowledge, community agency, and cross-sector partnerships as foundational for sustainability.

Numerous studies illustrate that tourism can be structured to promote community empowerment and ecological conservation. Tobirin et al. (2024) note that effective tourism development in disaster-prone areas can enhance local capacities and serve as a socio-cultural safety net, enabling communities to leverage tourism for resilience-building and environmental conservation. Moreover, Estevão and Costa (2020) emphasize that small tourism enterprises in vulnerable areas often require capacity training to manage risks effectively. This aligns with the assertion that nurturing local entrepreneurship and fostering resilience directly contributes to sustainable outcomes in tourism sectors, as emphasized in research by Matusin et al. (2019). Their work indicates that a comprehensive vulnerability assessment is essential for sustainable tourism operations amid natural disasters, proposing that resilience frameworks should incorporate local insights to guide disaster preparedness effectively.

Finally, Karim et al. (2024) point to the crucial need for government interventions to support sustainable tourism development, particularly in disaster-prone areas. They highlight that such initiatives must include community stakeholders to ensure economic benefits are equitably distributed and foster long-term resilience.

This reimagining of tourism as a partner in empowerment and ecological stewardship is vital, particularly in areas vulnerable to natural disasters. By integrating community needs, local knowledge, and sustainable practices, tourism can transform from a potential hazard to a substantial asset for resilience building. Engaging in such collaborative efforts not only aids in the recovery from disasters but also contributes to creating sustainable livelihoods and enhancing community agency, ultimately supporting broader global sustainability agendas.

Defining Social Innovation in Context

Social innovation is conceptualized as new ideas, practices, or processes designed to meet unmet social needs, thereby enhancing community capabilities in addressing complex challenges. Unlike traditional technological innovation, which often focuses on product or system enhancements, social innovation emphasizes relational dynamics and processes that are context-specific. It is characterized by grassroots initiatives and participatory governance, enabling collaborative efforts among various actors across different sectors. This focus on collaboration is

essential in achieving sustainable outcomes, as it fosters community engagement and ownership of social change.

Research by Moulaert et al. supports the notion that social innovation thrives on social relationships and interaction, stressing the importance of community involvement and participatory practices for meaningful change. Additionally, Adomako and Nguyen Adomako & Nguyen (2024) highlight the role of institutional support and social legitimacy in enhancing performance outcomes for collaborative entrepreneurship and social innovation efforts. Costa et al. (2021) discuss participatory aspects of open innovation, emphasizing how collaborative platforms aid in creative co-creation and innovation within communities.

Furthermore, studies by Kasumaningrum et al. (2024) illustrate how cross-sector collaboration significantly impacts social innovation by breaking down barriers and enhancing community capacities. This aligns with Malmström and Johansson's (2015) emphasis on the importance of trust and social exchanges in collaborative projects, reinforcing the role of relational dynamics in successful social innovation initiatives. Finally, the work of Peters et al. (2018) provides insights into how social innovations can be initiated by various actors, including individuals, social enterprises, and governmental bodies, thereby demonstrating the versatility and broad application of social innovation practices across different contexts. Social innovation serves as a pivotal mechanism for addressing complex societal challenges by promoting collaboration, integrating community insights, and transforming vulnerabilities into opportunities for empowerment. Emphasizing relational and participatory approaches enriches the capacity of communities to navigate and respond to their unique circumstances, reinforcing the need for ongoing research and application of these innovative practices in various social contexts.

Social innovation plays a crucial role in disaster-prone tourism villages through various manifestations, including the establishment of community-based early warning systems, economic restructuring around tourism, and the creation of inclusive institutions that facilitate the balance between external assistance and local priorities. In contexts where communities face recurrent disasters, the need for effective responses to risks is heightened. Social innovation addresses this need not through high-tech solutions but via incremental changes that are embedded within local cultures and practices. This approach is vital for developing sustainable mechanisms that allow communities to adapt to and manage the complexities of their environments. For instance, Macherera and Chimbari (2016) highlight the significance of community-based early warning systems (CBEWS), which are defined as locally managed initiatives that empower residents to take an

active role in disaster preparedness. These systems enhance risk awareness among community members and build local capacities, creating a resilient framework for responding to disasters. Subagyo et al. (2022) complement this view by presenting a Pentahelix policy management approach, which integrates multiple stakeholders—government, business, academia, the media, and the community—to improve disaster management efforts. This model emphasizes community engagement as a fundamental component of effective disaster risk reduction.

Moreover, Khanm et al. (2024) discuss how frameworks that align with the Sendai Framework for Disaster Risk Reduction facilitate the integration of social innovation into disaster preparedness, ensuring that local insights and capacities are central to these efforts. This literature affirms that social innovation is crucial in defining institutions that mediate between external support and community-led priorities, thus reinforcing the significance of participatory governance in fostering resilience. Furthermore, a study by Geumpana et al. (2018) illustrates how social businesses can emerge as critical innovations post-disaster, aiding communities not only in immediate recovery but also in fostering longer-term resilience through sustainable livelihood strategies. Social innovation in disaster-prone tourism villages manifests through localized and culturally resonant initiatives that enhance communities' adaptive capacities. By establishing systems that promote local engagement and stakeholder collaboration, these innovations enable communities to manage risks effectively while integrating tourism as a means for enhancing resilience. Continued investment in social innovation is essential for fostering sustainable practices within these vulnerable areas.

Literature Review: Linking Tourism, Disaster Resilience, and Innovation

Research on community-based tourism (CBT) underscores the critical importance of local participation, benefit-sharing, and cultural authenticity, especially in Indonesia, where CBT is promoted as a key vehicle for rural development. Local engagement in tourism initiatives ensures that the benefits of tourism are distributed equitably among community members, enhancing local ownership and fostering cultural heritage. However, in disaster-prone regions, CBT confronts unique challenges such as infrastructural vulnerability, disrupted visitor flows, and increased perception of risk, which can undermine its effectiveness and sustainability.

Studies highlight the centrality of local participation in CBT. For example, Soeswoyo et al. (2022) articulate that many tourism initiatives in Indonesia struggle due to passive community involvement, emphasizing the necessity of well-organized and planned tourism

development to address environmental, social, and economic challenges. Similarly, Sudibyo et al. (2019) found that while rural tourism has potential for sustainability, many villages lack effective strategies tailored to their unique contexts. Moreover, Khorasani et al. (2017) illustrate how cultural tourism can empower local communities and generate pride in local traditions, aligning with the objectives of CBT to enhance cultural authenticity and community engagement. However, the challenges posed by natural disasters can complicate these efforts; as highlighted by Rero and Milyardo (2022), the infrastructure vulnerability in disaster-prone areas can lead to decreased visitor confidence and substantial disruptions in tourism activities. Next, Sari et al. (2023) discuss how sustainable tourism development can bolster community welfare, particularly in rural areas facing economic challenges. Their findings suggest that government and institutional support is crucial in overcoming the infrastructural challenges posed by natural disasters, which can impede tourism development in vulnerable regions. While community-based tourism has significant potential as a vehicle for rural development in Indonesia, its success, particularly in disaster-prone areas, is contingent upon addressing the unique challenges faced by these communities. Increasing local participation, ensuring equitable benefit-sharing, and fostering cultural authenticity must be prioritized to enhance resilience and sustainability in the face of disasters. Continued research and tailored interventions can provide the necessary frameworks for effectively integrating CBT within these challenging contexts.

Studies by Hidayati (2016) and Rozi et al. (2020) have shown that tourism villages near Mount Merapi have managed to sustain tourism activities by incorporating disaster narratives into their tourism offerings — such as "lava tours", disaster museums, and storytelling by survivors. These activities not only attract tourists but also function as collective memory practices that reinforce communal identity and preparedness. Meanwhile, literature on disaster risk reduction (DRR) emphasizes the role of local knowledge and adaptive governance in enhancing community resilience (Gaillard & Mercer, 2013). The integration of DRR and tourism development, however, remains fragmented both in policy and practice. There is limited scholarly work that explicitly connects social innovation to tourism development in disaster contexts, particularly in Indonesia. This gap underscores the need for interdisciplinary research that bridges tourism studies, disaster studies, and innovation studies.

On the innovation side, the Quintuple Helix model (Carayannis & Campbell, 2010) offers a useful framework to understand how government, academia, business, community, and environment interact in producing innovation. In the case of tourism villages in Sleman, this model can help map the roles of different actors — such as local tourism offices, village

cooperatives, universities like UGM, NGOs, and digital platforms — in supporting community resilience through tourism.

Mount Merapi and the Emergence of Resilient Tourism Villages

The villages surrounding Mount Merapi offer a compelling case of how disaster vulnerability can coexist with innovation and hope. The 2010 eruption, one of the most destructive in recent memory, devastated much of the southern and eastern slopes of the volcano. Yet, in its aftermath, communities rallied together to rebuild their lives — not merely returning to pre-disaster normalcy but reimagining their future through tourism and entrepreneurship.

Pentingsari, one of the most well-known tourism villages in Sleman, exemplifies this transformation. Once an agricultural village with minimal visitor interest, it has become a model of CBT by integrating environmental education, traditional crafts, and disaster storytelling into its tourism package. Visitors are not only entertained but also educated about living with risk — a key feature of *resilience tourism*.

Glagaharjo and Umbulharjo follow similar trajectories. Their initiatives include community-based tour guides trained in volcanology, the establishment of disaster museums, and the development of tourism packages that include evacuation route tours, lava dome observation, and cultural rituals associated with Mount Merapi. These villages illustrate how *social innovation* is not imposed from outside but rather emerges from within, shaped by lived experience and collective memory.

Methods

Research Design

This study employed a **qualitative-explorative case study** approach to explore social innovation processes in disaster-prone tourism villages. The qualitative method was chosen to understand deeply the contextual dynamics of innovation practices, stakeholder interaction, and community responses to disaster risks. The case study approach enabled the researchers to investigate contemporary real-life phenomena within the bounded system of tourism villages located on the slopes of Mount Merapi, Sleman Regency, Yogyakarta.

The research emphasizes **naturalistic inquiry**, allowing phenomena to be interpreted through participants' perspectives and lived experiences. The study also integrated **constructivist epistemology**, assuming that knowledge about social innovation in these communities is co-constructed through interaction between researchers and informants.

Population and Sample (Target of Research)

The target population of this study comprised stakeholders involved in the development of community-based tourism in three selected villages:

Pentingsari Village (Cangkringan District), Glagaharjo Village (Cangkringan District), and Umbulharjo Village (Cangkringan District), all located on the southern and southeastern slopes of Mount Merapi.

The **sample** was determined using **purposive sampling** technique, focusing on key actors and individuals with direct involvement or knowledge in village tourism and disaster resilience initiatives. The participants included:

1. Village heads and members of tourism village management groups (Pokdarwis),
2. Community leaders and elders,
3. Representatives from local government (e.g., Tourism Office, Disaster Management Agency – BPBD),
4. University researchers and extension agents,
5. NGOs facilitating disaster education and economic development programs,
6. Local youth and women's groups involved in tourism activities.
7. In total, **21 informants** were involved in the study.

Data Collection Techniques and Instrument Development

a. Presence of the Researchers

Researchers were present on-site for participatory observation and conducted multiple field visits between **September and December 2024**. Researchers acted as facilitators and observers to reduce power imbalances and encourage open dialogue.

b. Data Collection Techniques

The study used **triangulated data collection techniques** to enhance the credibility and validity of the findings. These included:

1. **In-depth interviews** using semi-structured interview guides. The guide contained open-ended questions related to innovation practices, stakeholder collaboration, local knowledge, and tourism development.
2. **Focus Group Discussions (FGDs)** with community members (conducted separately with youth groups and women entrepreneurs),
3. **Participatory observation** during tourism activities, disaster drills, and community meetings,
4. **Document analysis**, including local regulations, village development plans, tourism promotional materials, and social media content.

Audio recordings were made with consent, and field notes were maintained throughout the data collection process.

c. Instruments

The main instrument was the **researcher**, supported by:

1. An **interview guide** developed based on themes of social innovation, Pentahelix collaboration, and community resilience,
2. An **observation checklist** to assess community participation, infrastructure, and innovation outputs,
3. A **document analysis matrix** for triangulation and content mapping.

All instruments were pilot-tested in a similar non-study village in the Merapi area to ensure clarity and relevance.

d. Location and Duration of the Research

1. **Research Location:** Pentingsari, Glagaharjo, and Umbulharjo Villages, all in Cangkringan Subdistrict, Sleman Regency, Yogyakarta Special Region.
2. **Duration:** The field research was conducted over **four months**, from **September to December 2024**.
3. **Geographical context:** All villages are located within a 5–10 km radius from the summit of Mount Merapi and are categorized as high disaster-risk zones (Kawasan Rawan Bencana - KRB II/III).

Results

Overview of Social Innovation Practices in Merapi Tourism Villages

The analysis of field data revealed that social innovation in the three selected tourism villages—Pentingsari, Glagaharjo, and Umbulharjo—manifested in multiple forms. These include the integration of local wisdom into tourism experiences, the establishment of community-led governance models, the transformation of post-disaster landscapes into tourism assets, and the creative use of digital technology to market local products.

Social innovations are not isolated events but emerge as responses to long-standing community challenges, particularly the cyclical eruption of Mount Merapi. Community actors have developed adaptive tourism practices that not only provide economic value but also reinforce disaster awareness and strengthen social cohesion.

Typology of Social Innovation

Social innovations observed in the field can be categorized into three main types:

Institutional and Governance Innovation

One of the strongest innovations lies in the formation and functioning of *Pokdarwis* (Tourism Awareness Groups). These community-based organizations operate as local tourism managers, responsible for planning, organizing, and evaluating tourism activities.

Table 1 illustrates the comparative governance characteristics across the three villages:

Table 1. Community-based Tourism Governance Structure

Village	Pokdarwis Role	Decision-Making Model	External Collaboration
Pentingsari	Core organizer of all tourism units	Participatory consensus	Strong ties with UGM & NGOs
Glagaharjo	Coordinator of community guides	Semi-hierarchical model	Partnership with BPBD
Umbulharjo	Focused on marketing and packaging	Youth-driven collective	Support from village-owned enterprises (BUMDes)

Community meetings are held monthly to evaluate tourism programs, resolve conflicts, and plan new initiatives. These practices strengthen participatory democracy at the grassroots level and enable flexible, responsive governance.

Economic and Livelihood Innovation

In response to the declining viability of agriculture post-eruption, communities have diversified their livelihoods through tourism-related microenterprises. Key innovations include:

- Homestay development using traditional architecture,
- Culinary tourism based on volcanic soil-based ingredients,
- Handicraft workshops using volcanic ash and stone.

(1) In Pentingsari, a “Live Like a Local” tourism package provides guests with hands-on farming, cooking, and cultural performance experiences. (2)

Glagaharjo features “Disaster Route Tours” that follow past lava paths and include visits to evacuation shelters. (3) Umbulharjo promotes Merapi-inspired art workshops and local café hubs showcasing youth creativity.

Figure 1. Forms of Economic Innovation in the Three Villages

(a) Visitors learning to weave bamboo baskets in Umbulharjo; (b) Community members preparing volcanic ash for craft production in Glagaharjo.

! [Figure 1 Placeholder – to be inserted in final layout]

These activities not only provide income but also serve as platforms for cultural transmission and trauma healing.

1.3. Cultural and Knowledge-Based Innovation

The use of local wisdom and disaster memory is central to the innovation process. Instead of perceiving Merapi solely as a threat, the communities frame it as a "source of life and learning." This paradigm is visible in:

- The narrative design of tour guides that emphasize traditional cosmology of the mountain,
- The integration of folklore and local rituals (e.g., *Labuhan Merapi*) into tourism packages,
- Community documentation projects that preserve oral histories of past eruptions.

Table 2. Examples of Local Wisdom Embedded in Tourism Products

Innovation Type	Example from Field	Cultural Significance
Ritual integration	Labuhan reenactments ritual	Honoring spirits of Merapi
Storytelling tourism	Survivor narrative tours	Shared trauma, collective memory
Gastronomic heritage	<i>Tiwul</i> cooking class	Food security in eruption times

This form of cultural innovation promotes resilience by validating local knowledge and creating a sense of continuity in a volatile environment.

Technological and Digital Innovation

The study found a marked shift in how tourism is marketed and communicated, particularly post-COVID-19. Youth groups in all three villages have become instrumental in digital branding efforts.

1.4.1. Digital Promotion and Branding

Using platforms such as Instagram, TikTok, and YouTube, local youth teams produce storytelling videos, live virtual tours, and product promotions. The aesthetic emphasis is on “authenticity” and “resilience,” featuring scenes of daily life and disaster adaptation.

Glagaharjo’s Instagram page, for instance, includes drone footage of lava fields, testimonials from survivors, and disaster education infographics.

1.4.2. E-Commerce and Local Product Digitization

Some homestays and souvenir products are now available through online marketplaces (Shopee, Tokopedia), although digital financial literacy remains a challenge for older villagers. Digital skills training, often facilitated by university students, plays a critical role in reducing the generational gap in innovation capacity.

1.5. Drivers of Social Innovation

Interviews and thematic analysis indicate several key enabling factors:

(1) **Trauma as a Catalyst:** The shared experience of disaster trauma acts as a bonding mechanism and a driver for collective action. (2) **Leadership and Local Champions:** Individuals with strong commitment and vision (village heads, Pokdarwis leaders) play a catalytic role in initiating innovation. (3) **External Linkages:** Partnerships with universities (e.g., UGM, UNY), NGOs, and the private sector provide technical assistance, training, and exposure. (4) **Regulatory Space:** Regional policies that recognize tourism villages as priority development zones create a supportive policy environment.

1.6. Barriers and Limitations

Despite the achievements, several barriers remain:

- **Infrastructural constraints**, such as damaged roads and limited internet connectivity in Umbulharjo;
- **Unequal capacity** among community members, with older residents sometimes resistant to change;
- **Dependency risks** from overreliance on tourism, particularly in low visitor seasons or during new volcanic activity;

- **Fragmented collaboration**, where different stakeholders pursue separate agendas without shared monitoring mechanisms.

These constraints challenge the scalability and sustainability of innovations, emphasizing the need for continuous learning and adaptive governance.

1.7. Impact of Social Innovation on Community Resilience

The cumulative effect of the innovations has been a measurable increase in:

- Household income diversification,
- Risk awareness and preparedness behaviors,
- Youth involvement in productive sectors,
- Cultural pride and intergenerational knowledge transfer.

Figure 2. Perceived Impact of Tourism Innovation on Resilience

(a) Bar chart showing increased disaster preparedness across three villages (from survey data); (b) Word cloud of most-used community terms in interviews (e.g., “gotong royong,” “tangguh,” “leres”).

[Figure 2 Placeholder – to be inserted in layout]

These results validate the argument that **social innovation enhances not only economic outcomes but also socio-psychological and institutional resilience**.

1.8. Summary of Key Findings

To summarize, social innovation in Merapi’s tourism villages operates at multiple levels—governance, economy, culture, and technology. The most successful initiatives are those that:

(1) Draw on lived experience and local knowledge, (2) Foster multi-stakeholder collaboration through the Pentahelix or Quintuple Helix frameworks, (3) Combine tradition with new media and youth energy, (4) Are flexible enough to adapt to new risks and opportunities.

These findings provide a compelling case for rethinking disaster-prone rural areas not as zones of limitation but as **laboratories of innovation and resilience in action**.

Discussion

Interpreting Social Innovation in a Disaster-Prone Tourism Context

The findings of this study reveal that social innovation within the context of disaster-prone tourism villages in Sleman Regency is not merely a spontaneous reaction to crisis, but rather a complex, deliberate, and context-sensitive process rooted in community agency. This aligns with the view of Moulaert et al. (2013), who define social innovation as both an outcome and a process that improves social relations and addresses unmet societal needs. In the case of Merapi's tourism villages, innovation takes the form of reimagining vulnerabilities into viable assets—transforming disaster memory into educational tourism, turning community trauma into shared narratives of strength, and leveraging cultural rituals as immersive visitor experiences.

This local transformation echoes the concept of "resilience tourism" (Becken & Hay, 2007), where tourism is designed not only to generate economic gains but to foster preparedness, social capital, and adaptive capacities among communities exposed to risk. What is particularly notable in this study is the embeddedness of innovation in community culture and governance traditions—where *gotong royong* (mutual aid) and local wisdom serve as drivers of participatory innovation.

The Role of Local Institutions and the Pentahelix Framework

The research underscores the pivotal role of community-based organizations such as *Pokdarwis* in institutionalizing innovation at the grassroots level. The *Pokdarwis* in the studied villages do not function as mere tourism operators but act as centers for mobilization, education, and intergenerational dialogue. Their participatory structure promotes both accountability and innovation ownership—reflecting the principle of “by the community, for the community.”

This resonates with the **Pentahelix model** of innovation collaboration (Yunus, 2017), where five major actors—government, academia, business, civil society, and media—co-create sustainable solutions. In the Sleman case, collaboration is evident in how village communities work with universities (e.g., Universitas Gadjah Mada), NGOs (e.g., LPPSP, Yayasan IDEP), and digital influencers to package and disseminate local tourism products. These collaborations strengthen the sustainability of innovations and ensure a continuous knowledge transfer, a finding consistent with the work of Carayannis & Campbell (2010) on the **Quintuple Helix**, which includes ecological sustainability as a fifth dimension.

However, while multi-stakeholder frameworks are promoted widely in policy discourse, their real-world application remains uneven. In Glagaharjo, for instance, there were tensions between village leaders and external actors

over control of branding and access to funding. This calls attention to power asymmetries within the Pentahelix interaction, suggesting that collaboration alone does not guarantee equitable innovation unless mechanisms of shared governance and transparency are in place.

Economic Diversification and Adaptive Livelihoods

One of the most impactful findings is the communities' success in developing **adaptive livelihoods** through tourism. As previous eruptions disrupted traditional agriculture and livestock-based economies (Surono et al., 2012), the pivot toward homestay development, culinary entrepreneurship, and eco-tourism experiences reflects a form of economic resilience. This is supported by literature on sustainable rural livelihoods (Chambers & Conway, 1992) that emphasize the importance of diversification and local ownership in managing risk.

Moreover, the emphasis on **culturally rooted tourism products**—such as disaster storytelling tours, Merapi-inspired handicrafts, and food heritage experiences—illustrates the alignment between cultural preservation and economic empowerment. This contradicts earlier critiques that tourism leads to cultural commodification (Cohen, 1988). Instead, in these villages, culture is not “sold” but *shared*, often through performative education aimed at disaster awareness and moral reflection.

The rise of youth-led digital marketing and e-commerce also indicates a generational shift in the mode of innovation diffusion. Social media platforms serve as both promotional and educational tools, further blurring the lines between economic activity and public education.

Cultural Resilience and Disaster Memory as Innovation Resources

The study reveals a profound re-signification of disaster experiences in tourism narratives. Mount Merapi is not depicted as a symbol of destruction, but as a sacred entity (*Gunung Agung*) that teaches humility, solidarity, and environmental ethics. Local rituals such as *Labuhan Merapi* are not simply retained as touristic spectacles but are embedded in community values and intergenerational learning. This challenges the binary between “modern” disaster education and “traditional” knowledge systems.

Gaillard & Mercer (2013) advocate for the integration of local and scientific knowledge in risk reduction efforts, and the Merapi case presents a living example of such synthesis. Local storytelling of eruption cycles, safe routes, and ancestral practices have been incorporated into official tour routes and disaster learning centers.

This cultural lens expands the concept of resilience beyond infrastructural preparedness or institutional capacity into the realm of **symbolic and**

narrative resilience, where communities draw strength from memory and meaning-making.

Barriers to Innovation: Structural and Generational Challenges

Despite these promising outcomes, several limitations inhibit the scaling and deepening of innovation:

1. **Infrastructure and digital access** remain uneven, particularly in Umbulharjo, where poor road access and weak internet connectivity limit market reach.
2. **Generational divides** affect innovation adoption, as older residents often lack digital literacy and rely on conventional tourism channels.
3. **Institutional fragmentation**, as seen in competition among Pokdarwis units, BUMDes, and private tour operators, occasionally leads to conflicting priorities.
4. **Policy inconsistency**, where top-down tourism promotion does not always consider local risk assessments or sustainability capacities.

These barriers reflect findings from Hall et al. (2016), who argue that innovation in tourism systems is often constrained not by a lack of ideas, but by **institutional inertia, market rigidities, and weak governance coordination**. Therefore, capacity building alone is insufficient—what is needed is institutional harmonization and long-term support mechanisms.

Implications for Policy and Practice

The implications of this study are multi-fold:

- (1) **Tourism in disaster-prone areas** should be recognized not just for its economic potential, but for its capacity to serve as a platform for education, identity reconstruction, and community healing.
- (2) **Social innovation policies** must support flexible funding schemes, foster trust-building between local and external actors, and provide sustained mentorship rather than one-off interventions.
- (3) **Tourism governance** in such contexts must be decentralized and participatory, allowing community members to define their own narratives, set boundaries, and prioritize local values.
- (4) **Education and training** must address not only technical tourism skills but also disaster knowledge, cultural literacy, and digital entrepreneurship, especially for youth and marginalized groups.
- (5) **Monitoring and evaluation frameworks** for tourism innovation should incorporate indicators of social cohesion, knowledge retention, and risk awareness—not just visitor numbers or revenue figures.

Future Research Directions

This study opens several avenues for future investigation:

1. **Comparative studies** between Merapi and other disaster-prone tourism regions (e.g., Sinabung, Bromo, Lombok) to assess how different socio-ecological systems mediate innovation pathways.
2. **Longitudinal research** to track the sustainability of innovations across multiple eruption cycles or crises (e.g., pandemics, climate shocks).
3. **Gender-focused analysis** to understand how innovation processes are shaped by and affect women, especially in domestic-based tourism economies.
4. **Technological integration studies** exploring the role of AI, AR/VR, and digital mapping in enhancing disaster-based tourism narratives.
5. **Quantitative resilience assessments** to measure innovation impacts on household income, preparedness scores, and psychological well-being.

Such inquiries would deepen the understanding of social innovation not as a static outcome, but as a **continuous adaptive cycle**, embedded in everyday community practice and resilience-making.

Conclusion

This study examined how social innovation is practiced and institutionalized within disaster-prone tourism villages on the slopes of Mount Merapi, Sleman, Yogyakarta. The research revealed that social innovation is not only a coping mechanism in the face of volcanic threats but also a transformative process that fosters community resilience, cultural preservation, and inclusive economic development. Through qualitative inquiry in three tourism villages—Pentingsari, Glagaharjo, and Umbulharjo—this research identified a variety of innovative practices across institutional, economic, cultural, and technological domains.

The main argument advanced in this paper is that **resilience and innovation are deeply rooted in the local context, shaped by collective memory, leadership, and multi-actor collaboration**. In these communities, the legacy of disaster has become a source of learning, identity, and creative reinvention. By framing Merapi not only as a hazard but also as a heritage, local actors have succeeded in turning vulnerability into value.

Social innovation in these villages is characterized by:

- Participatory tourism governance through Pokdarwis and BUMDes,

- Livelihood diversification into homestays, local crafts, and educational tourism,
- Cultural integration through disaster storytelling and ritual reenactment,
- Digital mobilization by youth in branding, e-commerce, and outreach.

The findings reaffirm that innovation is not the exclusive domain of cities or high-tech clusters—it can and does emerge in rural, peripheral, and high-risk areas, provided that local agency, trust, and enabling environments exist.

Policy Implications

Based on the empirical findings, several policy recommendations are proposed:

1. **Institutionalize Community-Based Tourism Governance** Local governments should formalize and support Pokdarwis and village-based tourism cooperatives as recognized instruments of rural innovation and disaster preparedness. Legal frameworks should allow for autonomy in decision-making, financial sustainability, and access to public-private partnerships.
2. **Strengthen Multi-Stakeholder Collaboration (Pentahelix Model)** Interventions from universities, NGOs, and the private sector must go beyond one-off projects. Collaborative innovation hubs should be established at the village or sub-district level to coordinate ongoing training, evaluation, and scaling of innovations.
3. **Promote Integrated Education Programs** Cross-sector education programs that combine tourism skills, disaster risk education, cultural heritage, and digital literacy should be introduced in formal and non-formal settings, targeting youth and women as primary agents of transformation.
4. **Provide Infrastructure and Connectivity Support** Investment in basic infrastructure—especially road access, signage, and internet—must be prioritized in disaster-prone areas to support both safety and innovation scalability.
5. **Develop Innovation Impact Metrics** Regional tourism and disaster agencies should adopt new indicators that capture social innovation outcomes, such as community participation levels, intergenerational knowledge transmission, and psychological recovery—beyond just visitor numbers or revenue.

Future Research

While this study offers rich insights into the dynamics of social innovation in Merapi's tourism villages, it also opens up several directions for further research:

- **Longitudinal studies** to monitor how innovation practices evolve across multiple disaster cycles or external shocks (e.g., pandemics, political shifts).
- **Comparative research** across different disaster-prone regions in Indonesia or Southeast Asia to explore contextual enablers and barriers.
- **Impact evaluation studies** to measure how specific innovations affect indicators of resilience, such as income stability, preparedness behavior, and youth migration.
- **Gendered innovation studies** to explore how innovation processes are influenced by and impact gender roles, labor divisions, and leadership representation.

Finally, scholars and practitioners should move toward **co-creating knowledge** with communities rather than merely extracting it. Participatory research, when embedded in local development, can itself become a form of social innovation—bridging theory and practice in the quest for more resilient and empowered societies.

Declarations

Author Contribution Statement

All authors contributed equally to the development of this article. Joko Irwanto conceptualized the research design, conducted the fieldwork, and led the data analysis. Nurul Hidayat was responsible for the literature review, drafting of the theoretical framework, and assisting in field coordination. Ahmad Ramadan supported data interpretation, figure and table development, and contributed to the final editing and formatting of the manuscript. All authors have read and approved the final version of the manuscript.

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Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request. Interview transcripts, observation notes, and supporting documentation have been archived in a secure institutional repository and are not publicly available due to confidentiality agreements with informants.

Declaration of Interests Statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Additional Information

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