

Strengthening the Resilience of Sugihen Tourism Village to Climate Change through Digital Innovation and Green Tourism

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Abstract. The aim of this study was to investigate how resilience, digital innovation, and green tourism can enhance climate change adaptation in Sugihen Tourism Village, North Sumatra. Through a stratified proportional random sampling procedure, 300 respondents representing tourism company owners, local communities, village government, tourism awareness groups, and tourists were surveyed to collect quantitative data. Surveys and interviews were used to collect primary data, while government statistics and relevant publications were used to collect secondary data. Structural Equation Modeling (SEM) using SmartPLS 4 was used for data analysis. The findings revealed that climate change adaptation was positively and significantly influenced by resilience, digital innovation, and green tourism. Furthermore, the relationship between resilience and climate change was significantly mediated by digital innovation and green tourism, indicating that the adoption of sustainable tourism practices and technological solutions is more common in resilient areas. These results imply that combining digital innovation with green tourism tactics can enhance tourism competitiveness, promote sustainable local development, and improve climate resilience at the village level. Policymakers and stakeholders in rural tourism destinations facing climate change issues can benefit from this research's conceptual model, which integrates digital transformation, socio-ecological resilience, and environmentally conscious tourism.

Keywords: Climate Change, Digital Innovation, Green Tourism, Resilience, Tourism Village.

1 Introduction

The national and international tourism industry, as well as tourist settlements like Sugihen in North Sumatra, are under serious threat from climate change. Environmental sustainability, tourism, and local livelihoods have all been directly impacted by rising global temperatures, unpredictable weather, and increased natural disasters [1],

[2]. According to the Intergovernmental Panel on Climate Change [3], global temperatures have increased by 1.1°C since pre-industrial times, with significant impacts on coastal areas like North Sumatra, which have a tropical climate.

Unfavorable environmental conditions are also a contributing factor to climate change in Indonesia; a tourist destination's environment will be considered positive if it benefits the wider community, and negative if it doesn't. Conversely, a tourist destination's environment includes geographic location, weather, and noise levels.

Based on data obtained from [4], negative environmental consequences created at a destination will have an impact on tourism, namely

Table 1. Negative Environmental Consequences on Tourism

Issues	Activities	Problem Cause
Problems of natural resources, flora and fauna	Construction of airports on agricultural land in tourist areas. Draining of coastal wetlands. Depletion of coral reefs and ecosystems. Decline in plant and animal species. Displacement of indigenous peoples from their own territories.	Access to natural resources that are essential for their existence and means of livelihood will be denied to indigenous and local communities. Ecological ecosystems can experience direct damage due to land conversion for tourism development. Since tourism resources cannot be exploited by other sectors of economic growth, there are opportunity costs associated with their utilization.
Human behavior and environmental issues	Tourists harvesting coral for sale Disturbing fauna and feeding habits Tourists walking on coral reefs Using dynamite to catch fish for consumption; and Increasing crime, prostitution, and other issues at tourist destinations. Western visitors visiting ancient mosques without proper attire are examples of cultural appropriation.	Local communities, driven by tourists, may behave inappropriately and show a lack of environmental concern. This can have a variety of negative impacts on the natural and cultural environment.
Water, noise, air and aesthetic pollution	Waste disposal; Mountain air pollution; and The role of carbon emissions from aircraft in global warming. Noise pollution Changes in the average price of tourist accommodation development along the coast	Pollution impacts are often linked to the level of tourism development as well as the level of environmental management planning, implementation and control.

Comparing the above facts regarding the detrimental environmental impacts of tourism with the conditions faced by Sugihen Village in Karo Regency, North Sumatra Province, reveals a gap between the village's enormous potential and its inadequate management. Beautiful natural resources, a wealth of local knowledge, and substantial ecotourism growth prospects are hallmarks of Sugihen Village. However, this potential has not significantly impacted community well-being due to poor digital technology utilization, limited climate resilience, and a lack of an embedded green tourism concept.

This research utilizes Elinor Ostrom's Socio-Ecological Systems (SES) Theory, which explains how ecological systems and social institutions interact dynamically in the management of shared resources. According to SES theory, adaptive capacity, feedback mechanisms, and governance structures are key drivers of long-term resilience. In the context of Sugihen Tourism Village, resilience refers to the ability of interrelated social, environmental, and institutional subsystems to adapt to climate change.

According to the Intergovernmental Panel on Climate Change's Climate Resilience and Adaptation Framework, exposure, vulnerability, and adaptive capacity all influence climate resilience [3]. This study positions green tourism and digital innovation as drivers of rural tourism systems' ability to adapt.

This study incorporates Community-Based Tourism Theory (CBT), which offers a theoretical framework for examining how village institutions and Pokdarwis contribute to resilience. CBT highlights community involvement, local governance, and equitable benefit distribution as the foundations of sustainable tourism development [5].

According to [6], the Smart tourist Ecosystem Model describes how government, stakeholders, and digital technology interact within an integrated tourist ecosystem. As a result, digital innovation is viewed as a systemic driver of environmental monitoring and adaptive governance rather than just as marketing.

Economic viability, environmental integrity, and social equality are all integrated in John Elkington's Triple Bottom Line (TBL) Sustainability Framework. The environmental and social pillars of TBL are reflected in Sugihen's green tourism practices, while digital innovation supports economic sustainability by increasing efficiency and competitiveness.

Conceptually, the fundamental socio-ecological capacity that enables adaptive change is resilience. Operationally, resilience is transformed into climate adaptation outcomes through the use of digital innovation and green tourism. Digital innovation improves government coordination, information systems, and environmental monitoring, while green tourism combines community engagement and ecologically conscious activities. Therefore, resilience has both direct and indirect impacts on climate adaptation through digital and green transformation processes.

Tourist visits are likely to decline due to environmental damage, climate and weather changes, and other factors [7]. According to data from the Central Statistics Agency [8], climate impacts and non-adaptive infrastructure are contributing to the decline in the number of foreign tourists visiting ecotourism destinations.

The issues faced by Sugihen Tourism Village, which depends on the local culture and natural beauty, are comparable. The need for creative and sustainable resilience

strategies is evident in the declining quality of ecotourism attractions, decreasing agricultural yields as part of its agrotourism program, and infrastructure damage from extreme weather [9],[10],[11],[12].

Based on field observations, the Village Development Planning Meeting (Musrenbang) in Sugihen has implemented adaptation measures, including preparing well drilling, procuring seeds, and procuring animal feed. However, these measures are reactive and have not been integrated into a long-term resilience plan. Lack of collaboration with the district government and a lack of cross-sector training in agriculture, livestock, and tourism make it difficult for the hamlet to recover and adapt to climate shocks.

The potential for digital innovation has not been optimal due to low digital literacy, poor internet infrastructure, and a lack of information technology training, even though village governments have utilized social media platforms such as Facebook and Instagram for marketing.

While sustainable tourism in Sugihen Village holds much promise, its implementation remains minimal. Waste management is patchy, environmental education initiatives for local residents and tourists have never been implemented, and plans to use solar panels for street lighting remain unfulfilled. Due to the lack of an active tourism awareness organization, community involvement in tourism remains limited to concrete initiatives such as irrigation and rice field maintenance, with no measurable sustainability initiatives.

Green tourism and digital innovation are two strategic approaches that have proven successful in increasing the resilience of tourist destinations[13],[14],[15]. Digitalization enables the creation of sensor-based weather monitoring systems, community engagement platforms, and broader promotions. Meanwhile, green tourism encourages environmentally friendly behaviors, including the preservation of local culture, renewable energy, and better waste management [14],[15].

The novelty of this research compared to previous studies examining the vulnerability of local residents and socio-ecological adaptation mechanisms compared to other studies on the components of tourism village resilience to climate change [18],[5]. Subsequent studies [19],[20] focused on resilience in creating adaptive communities, while studies [21] examined how tourism villages survive change [22]. Research focused on methods for handling significant changes in tourism settlements [23],[24].

Since most studies concentrate on urban or developed destinations, this study combines resilience, green transformation, and digital innovation in an integrated framework, which is still very limited, especially in rural tourism villages in tropical regions that are vulnerable to climate change. Previous research has looked at climate adaptation in tourism, green tourism governance, and digital innovation separately. A systemic framework for climate change-resilient rural tourism transformation is provided by this study, which fills the aforementioned gap by integrating the IPCC Adaptation Framework, the Triple Bottom Line approach, the Smart Tourism Ecosystem model, the Socio-Ecological Systems theory, and the concepts of Community-Based Tourism into a structural model that empirically tests how resilience strengthens cli-

mate adaptation both directly and indirectly through digital innovation and green tourism.

Studies on new aspects of green tourism are being conducted with an emphasis on effective green tourism policies and practices [25],[26], [27],[28] conducted research on tourism impacts and sustainable solutions on a global scale. Studies focused on a comprehensive examination of sustainable tourism growth[29],[30],[31],[32] conducted research focusing on the difficulties and criticisms of the idea of sustainable tourism [33],[34] conducted research on global standards for introducing green tourism in small towns.

Furthermore, the Digital Innovation aspect that is new in this study compared to previous studies, namely in research [6],[35] focuses on digital technology to strengthen the competitiveness of tourist destinations. Research [36],[37] focuses on the role of social media in shaping a more dynamic tourist experience. Research [38],[39],[40] focuses on the concept of smart tourist destinations and its impact on tourism management. Research [41],[42] focuses on the application of personalization technology in ecotourism. Research [43],[44] focuses on the use of big data in supporting destination management.

Furthermore, the aspects of resilience, green tourism, and digital innovation that are new in this study compared to previous studies, namely research [45],[46] focused on the relationship between the digital economy and green tourism. Research [47],[48] focused on the combination of climate adaptation strategies and technological innovation. Research [49],[50] focused on the use of digital platforms to strengthen the image of sustainable tourism. Research [51],[52] focused on how digital innovation accelerates the transition of tourist villages to green tourism. Research [53],[54] focused on the balance between innovation, ecotourism, and community resilience.

Given the urgency of implementing digital innovation and green tourism principles to enhance the resilience of Sugihen Tourism Village, this research is crucial. This combination is expected to mitigate its negative impact on the climate, improve the well-being of the local community, and sustainably enhance the tourism village's competitiveness.

2 Method

This study uses a cross-sectional survey technique with a quantitative research design. Three hundred respondents representing tourism company owners, local communities, village administration, tourism awareness groups, and tourists were chosen via proportional stratified random selection. The links between resilience, digital innovation, green tourism, and climate adaptation were tested using structural equation modeling, or SEM-PLS [55]. Furthermore, the quantitative results were contextualized using a restricted number of qualitative insights gleaned from field observations and village planning meetings (Musrenbang). The following graphic displays the technical flowchart for SEM:

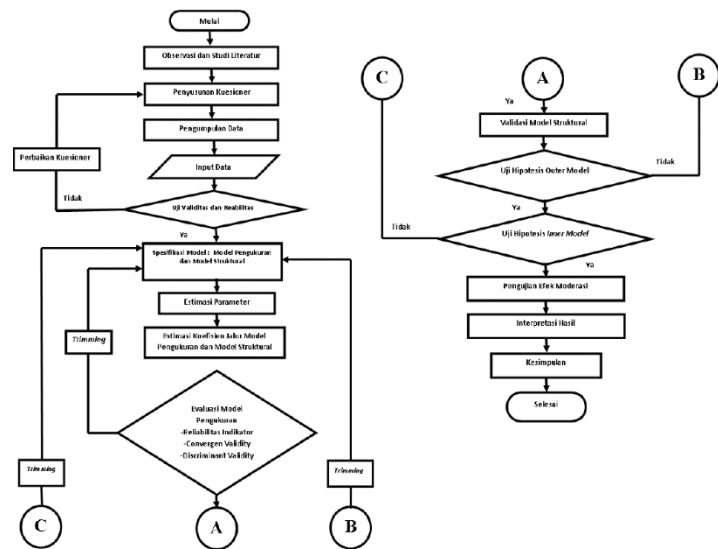


Fig. 1. Research Flow Chart

The research was conducted in accordance with the established procedure. The research was conducted in Sugihen Village, Juhar District, Karo Regency. The research period was from May to December 2025.

All parties involved in Sugihen Tourism Village who directly or indirectly support the growth of the tourism industry are the population of this study, including: Tourism Service Entrepreneurs (accommodation, food, and tourist transportation); Local Communities (tourist neighbours); Village Government and related organisations; Tourism Awareness Groups (Pokdarwis) consisting of 1,200 people who have visited Sugihen Village.

Sampling was conducted using the Slovin formula, resulting in a sample size of 300 respondents. The sampling technique was based on the Proportionate Stratified Random Sampling method, as shown in Table 2 below:

Table 2. Number Of Research Sample

No.	Sample	Calculation	Sample Size
1	Tourism Business Opera-tors	$25\% \times 300$	75 respondent
2	Local Community	$35\% \times 300$	105 respondent
3	Sugihen Village Govern-ment	$10\% \times 300$	30 respondent
4	Tourism Awareness Group	$15\% \times 300$	45 respondent
5	Tourists	$15\% \times 300$	45 respondent

This study uses both primary and secondary data sources. The Sugihen Village Government, local communities, tourism awareness groups, travelers, and operators of tourism-related businesses were all surveyed to gather primary data. Secondary data pertaining to the research subject or issue was gathered from the Central Statistics Agency, the Ministry of Tourism and Culture, and publications in national and international scientific journals.

The data collection instruments in this study used a Likert-scale questionnaire to measure the variables of resilience, climate change, digital innovation, and green tourism, as well as in-depth interviews with the Sugihen Village government. In developing the research questionnaire, all statements were formulated based on indicators for each research variable. In this case, there were four indicators for resilience, four for climate change, four for digital innovation, and four for green tourism.

SEM data analysis utilizing SmartPLS 4 software, which consists of to find factor structures, use exploratory factor analysis (EFA). For model validation and dependability, use Confirmatory Factor Analysis (CFA). To examine the connections between variables and the function of mediation, use structural equation modeling, or SEM [56].

3 Result

3.1 Respondent Description

The study's findings indicate that the following describes the study's respondents

Table 3. Respondent Description

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Toursim Busi- ness Operator	75	25.2	25.2	25.2
	Local Commu- nity	105	35.2	35.2	60.4
	Sugihen Village Government	30	10.1	10.1	70.5
	Tourism Awareness Group	45	15.1	15.1	85.6
	Tourist	43	14.4	14.4	100.0
	Total	298	100.0	100.0	

Source : SMART, 2025

The study's largest category, according to the descriptions provided by research participants, was the local community (35.2%), followed by tourist business players (25.2%). Accordingly, the study's primary focus was on how the community and corporate actors perceive and engage with tourism and climate change concerns. The existence of institutional and community components in tourist awareness is seen in the noteworthy participation of village administrations (10.1%) and tourism-aware

groups (15.1%). When it comes to gauging opinions on tourism management and its effects on the environment, tourists (14.4%) are considered external inputs.

The study's pentahelix strategy is shown in the comparatively equitable distribution of respondents among the key players (community, business actors, village administration, and visitors). In order to better understand how village resilience, digital innovation, green tourism, and climate change interact from the viewpoints of different stakeholders, this enhances the study's external validity.

3.2 Validity and Reliability Test

Convergent Validity.

The following are the validity test findings for this study, which are based on the outcomes of the data processing that was done:

Table 4. Discriminant Validity Fornell-Larcker Criterion

	Green Tourism	Digital Innovation	Climate Change	Resilience
Green Tourism	0.746			
Digital Innovation	0.801	0.738		
Climate Change	0.660	0.718	0.755	
Resilience	0.709	0.693	0.461	0.734

Source : Smartpls, 2025

The majority of the constructs in this model have satisfied the discriminant validity requirements, according to the findings of the discriminant validity test utilizing the Fornell-Larcker criterion. According to the Fornell-Larcker principle, the correlation between constructions outside the diagonal in the same column or row must be less than the square root of the Average Variance Extracted (AVE) value, which is on the diagonal (bold).

The AVE root values for each construct are as follows: Green Tourism (0.746), Digital Innovation (0.738), Climate Change (0.755), and Resilience (0.734). When compared with the correlations between constructs, it is evident that only the Digital Innovation construct has a higher correlation with Green Tourism (0.801) than its own AVE root mean square value (0.738). This indicates that the discriminant validity for Digital Innovation is not met, as this construct is statistically too similar to Green Tourism, suggesting a potential overlap in concepts.

Concurrently, the constructs of resilience, climate change, and green tourism demonstrate that their AVE root values exceed any correlations among them. The three notions thus satisfy the requirements for discriminant validity as they can be easily differentiated from one another. This model has strong discriminant validity overall, but the statistical connection between digital innovation and green tourism requires particular attention.

Construct Reliability.

The following reliability test findings are based on the outcomes of the data processing that was done for this study:

Table 5. Construct Reliability

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
Green Tourism	0.886	0.887	0.909	0.556
Digital Innovation	0.880	0.881	0.905	0.545
Climate Change	0.892	0.893	0.914	0.571
Resilience	0.877	0.879	0.903	0.538

Source : Smartpls, 2025

All four constructs—Green Tourism, Digital Innovation, Climate Change, and Resilience—have outstanding dependability, according to the findings of construct reliability testing.

Furthermore, all constructions' Composite Reliability scores, which ranged from 0.903 to 0.914, were above 0.90. Accordingly, these structures are dependable for measurement and have a very high degree of composite dependability.

All of the constructs had Average Variance Extracted (AVE) values between 0.538 and 0.571, which were all over 0.50. It may be inferred from this that the four conceptions satisfy the requirements for convergent validity as they account for over half of the variation in the indicators. As a result, the validity and reliability of this study tool in conceptually and statistically assessing each construct have been established.

3.3 Structural Model Testing

Direct Influence.

Table 6. Path Coefficient

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Resilience -> Climate Change	0.304	0.302	0.061	4.970	0.000
Digital Innovation -> Climate Change	0.161	0.163	0.050	3.198	0.001
Green Tourism -> Climate Change	0.282	0.286	0.059	4.747	0.000

Source : Smartpls, 2025

Resilience has a positive and substantial impact on communities' ability to adapt to climate change, as evidenced by the resilience variable's coefficient value of 0.304, T-Statistic value of 4.970, and P-Value of 0.000. Climate risk reduction is directly supported by the capacity to adapt and survive.

The digital innovation variable's coefficient value on climate change is 0.161, with a T-Statistic value of 3.198 and a P-Value of 0.001. This indicates that digital innovation significantly and favorably affects the mitigation of climate change. The application of digital technology enhances climate adaption.

Green tourism has a positive and significant impact on mitigating climate change, as indicated by the variable's coefficient value of 0.282, T-statistic value of 4.747, and P-Value of 0.000. It has been demonstrated that eco-friendly tourist activities improve resistance to the effects of climate change.

Indirect Influence.

To determine whether Green Tourism and Digital Innovation significantly mediate the influence of Resilience on Climate Change, two indirect mediation routes were examined based on the findings of testing particular indirect effects using the Structural Equation Modelling (SEM) technique. An analysis of the test results is provided below :

Table 7. Indirect Effects

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (O/STDEV)	P Values
Resilience -> Digital Innova- tion -> Climate Change	0.046	0.047	0.017	2.666	0.008
Resilience -> Green Tourism -> Climate Change	0.142	0.145	0.033	4.238	0.000

Source : Smartpls, 2025

These findings show that digital innovation has a major mediating role in bridging the gap between climate change and resilience. Since the p-value is less than 0.05 and the t-statistic value is over the significance level (1.96), it can be said that digital innovation strongly mediates this connection.

Digital innovations are more likely to be adopted by resilient communities, and their use improves their readiness and capacity for climate change adaptation. This indicates that enhancing resilience affects the climate directly as well as through digital channels that facilitate risk communication, destination management, and more adaptable information systems.

These findings suggest that there is a major mediating role of green tourism in the link between climate change and resilience. A p-value < 0.05 (even < 0.001) and a t-statistic value > 1.96 suggest that the mediating impact is statistically significant.

Stated differently, resilient communities are more likely to host green tourism activities, which in turn improves the village's ability to adapt to climate change.

This result highlights the value of promoting green tourism as a calculated means of maximizing the benefits of community resilience to climate change. Therefore, in addition to enhancing socio-ecological resilience, policy initiatives have to focus on specific ecotourism activities.

4 Discussion

4.1 Direct Effect Findings

Adaptation to climate change is directly influenced by village resilience. Villages that are more socio-ecologically resilient are better able to withstand the impacts of extreme weather, adapt to changing conditions, and respond to disasters. This reinforces the findings [19] and [20] stress how crucial transformability and adaptive capability are to community resilience. The ability of local communities to modify their tourist tactics in response to social change and environmental stresses is reflected in resilience in the tourism context, as stated by [21],[22]. The socio-ecological resilience of the village is not only linked to catastrophe response, but it also acts as a basis for concurrently advancing digitalization and eco-friendly tourist practices, according to the research findings in Sugihen.

From the standpoint of Socio Ecological Systems (SES), the results verify that Sugihen Tourism Village functions as a networked adaptive system in which technological infrastructure (digital innovation), sustainability practices (green tourism), governance capacity (resilience), and environmental stressors (climate change) all reinforce one another. According to SES theory, cross-scale interaction and institutional adaptation are the sources of resilience.

Climate change management is also greatly influenced by digital innovation. Although not yet fully developed, digital technology can improve early warning systems, weather information systems, and tourism site marketing and administration to be more effective and responsive to climate risks, based on the IPCC Adaptation Framework, green tourism reduces vulnerability by encouraging environmentally conscious behavior, while resilience and digital innovation increase adaptive capacity. Digital innovation serves as a governance integrator that links market access, environmental monitoring, and stakeholders from the standpoint of the Smart Tourism Ecosystem.

This study supports the conclusions of [36],[6] which demonstrate that digital technology can enhance the effectiveness of tourism services, allow for real-time environmental condition monitoring, and broaden the reach of promotion. The results of this study provide more proof that community resilience may be a major driver of digital change, even in rural regions like Sugihen where adoption rates of technology are low. The study, in this sense, closes a gap in the literature on the connection between digital preparedness and community resilience in the context of growing tourist communities.

From a Community Based Tourism perspective, improved institutional coordination and local involvement can enhance resilience. Green tourism acts as an interme-

diary, demonstrating how interaction with communities can transform resilience into beneficial environmental action.

Climate change mitigation has been shown to be greatly aided by green tourism. This demonstrates how enhancing Sugihen Tourism Village's ability to adapt to and mitigate the effects of climate change requires the adoption of sustainable tourism practices, such as waste management, the use of renewable energy, and the preservation of local culture, which reinforces the findings [29],[25]. According to the Triple Bottom Line paradigm, social inclusion and economic sustainability must be integrated at the same time for tourism communities to be climate resilient. This study demonstrate how environmental efficiency and conservation-based tourism strategies may reduce climate risks and boost destination competitiveness. But this study goes one step further by providing an empirical explanation of the connection between green tourism and climate change beliefs in the context of tropical tourist communities in hilly regions, which are still largely unexplored in the global literature.

4.2 Moderating Effect Findings

The findings of the indirect effects test show that the connection between Village Resilience and Climate Change is considerably mediated by Green Tourism and Digital Innovation. Resilience to Digital Innovation on Climate Change has a t-statistic value of 2.666 ($p = 0.008$), where as Resilience to Green Tourism on Climate Change has a t-statistic value of 4.238 ($p < 0.001$). This suggests that resilience has a direct impact on climate change adaptation, but it also strengthens that impact indirectly using digital technology and the growth of green tourism.

These findings' managerial implications underscore the necessity of an integrated strategy that views digital innovation and green tourism as key tools in village-level climate resilience initiatives. It is imperative that village governments and tourist managers give top priority to creating training modules on climate change adaptation that are closely related to sustainable destination management. Additionally, digitalization shouldn't be restricted to only advertising; it should also incorporate environmental monitoring systems, local weather apps, and community involvement via social media or interactive applications that promote ecological consciousness.

In the context of Sugihen Tourism Village, these results support the argument made in the proposal and interview results that digital innovation and green tourism practices have not yet been effectively incorporated into the community's and village institutions' adaptive ability. According to the Village Head's Sugihen statement during the interview, training has not adequately addressed climate change directly, and digital platforms are currently only being used for tourism marketing rather than education and climate risk reduction.

The village tourist management must create a policy plan that incorporates investments in green technology, including digital platforms for self-reporting, IoT-based trash management, and solar panels for lodging. Training programs for local human resources should also focus on developing green entrepreneurs that can market tourism services while protecting the environment. In this sense, resilience is an active

force in creating a sustainable tourism future rather than only a passive idea for surviving calamities.

In addition to making the hamlet more climate change-ready, this plan will solidify Sugihen's standing as one of North Sumatra's and Indonesia's most competitive smart tourist destinations.

4.3 Research Implication

Strengthening Village Resilience Capacity Through Adaptive Policy Support.

The results demonstrate the strong correlation between resilience and climate change readiness, green tourism, and digital innovation. However, the results of the interviews indicate that emergency response has not been socialized, human resources have not received information technology training, and climate adaptation continues to be restricted (e.g. borehole plans).

The policy implications that can be implemented are as follows: training programs for disaster risk management and climate adaptation must be created by local governments for community members and village leaders. In order to create local rules on climate change resistance and mitigation, village governments must be supported.

Accelerating Digital Transformation for Smart Tourism.

Responses to climate change are significantly impacted by digital innovation, according to SEM studies. Interviews, however, showed that no digital reservation system or travel app currently exists. There is still a lack of internet connection that does not satisfy government requirements or tourism marketing goals.

Policy implications that may be put into practice include: the development of digital infrastructure in tourist villages requires funding from the district and provincial governments. Technical support can be provided through the creation of online reservation systems and training in digital technology by the Ministries of Communication and Information Technology and Tourism and Creative Economy. It is necessary to incorporate the Smart Tourism Framework-based smart tourist village program into the medium-term development plan for Sugihen Village.

Strengthening Green Tourism through Environmental Regulation and Education.

Green tourism significantly impacts villages' preparedness for climate change, according to pilot results. According to sources, there are no programs for companies or visitors to learn about the environment. Ineffective waste management initiatives are caused by a lack of public awareness. Environmental certification, sometimes known as ecolabeling, is not yet considered significant.

Village governments can implement policy implications by enforcing laws and regulations on community-based waste management and sustainable tourism management. As part of village tourism development initiatives, district governments and environmental organizations can promote environmental certification. Partnerships with academic institutions or environmental non-governmental organizations can be

leveraged to implement community-based education initiatives on green tourism and conservation.

Cross-Stakeholder Collaboration to Reduce Climate Vulnerability.

Research shows that community resilience has a significant impact on the success of digitalization and green tourism. However, a lack of funding and organization leads to the failure of many projects. One of the biggest challenges is the continued low awareness of tourism.

Implementable policy implications include the establishment of a Pentahelix Collaboration Forum at the sub-district level, involving village governments, academics, the business world, communities, and the media. Local governments can provide performance-based Village Tourism Incentive Funds for implementing digitalization and green tourism.

5 Conclusion

According to this study, village resilience significantly influences climate change adaptation, both directly and indirectly through the mediating effects of green tourism and digital innovation. Each relationship between variables in the structural model is statistically significant. Key findings indicate that the capacity of Sugihen Tourism Village to adapt and survive the impacts of climate change increases with its level of resilience. Green tourism helps shape environmentally friendly tourism behavior and increases local engagement, while digital innovation mediates this relationship by improving the effectiveness of information management, promotion, and monitoring systems.

Climate adaptation training is lacking, technology utilization is suboptimal, and sustainable tourism practices are not routinely integrated into local tourism administration, according to empirical interviews with village officials. This indicates a gap between the implementation of sustainability-supporting tactics and the potential for resilience.

References

1. D. Scott, S. Gössling, dan C. M. Hall, "International tourism and climate change," *Wiley Interdiscip. Rev. Clim. Chang.*, vol. 11, no. 6, hal. 626, 2020.
2. Y.-Y. Sun, F. Faturay, M. Lenzen, S. Gössling, dan J. Higham, "Drivers of global tourism carbon emissions," *Nat. Commun.*, vol. 15, no. 1, hal. 10384, 2024, doi: 10.1038/s41467-024-54582-7
3. IPCC, *Climate Change 2023: The Physical Science Basis*. Cambridge University Press, 2023.
4. F. Eddyono, *Pengelolaan Destinasi Pariwisata*. Uwais Inspirasi Indonesia, 2021. [Daring]. Tersedia pada: www.penerbituwais.com%0A
5. R. Sharpley dan D. J. Telfer, *Tourism and Development: Concepts and Issues*. Channel View Publications, 2014.

6. U. Gretzel, M. Sigala, Z. Xiang, dan C. Koo, "Smart tourism: foundations and developments," *Electron. Mark.*, vol. 30, no. 1, hal. 1–10, 2020.
7. K. P. Ekonomi Kreatif, *Laporan Perkembangan Pariwisata Sumatera dan Strategi Branding Daerah*. Kemenparekraf RI, 2023.
8. BPS, *Statistik Pariwisata Sumatera Utara 2023*. BPS Provinsi Sumut, 2023.
9. Furqan dan Y. Putra, "Pengaruh Service Quality Terhadap Customer Satisfaction Taman Cadika Pramuka Johor di Medan," *TOBA J. Tour. Hosp. Destin.*, vol. 1, no. 1, hal. 01–06, 2022, doi: 10.55123/toba.v1i1.75.
10. R. Susanti, "The Role of Soft Skills in Digital Transformation: A Study of Urban Workforce Competitiveness," *Int. J. Bus. Technol. Manag.*, vol. 5, no. 3, hal. 143–158, 2021.
11. Y. Putra, E. D. Surya, S. Sitorus, dan A. Barus, "GLOBAL TOURIST BEHAVIOR TRENDS IN THE NEW NORMAL," *J. Akuntansi, Manaj. dan Ilmu Ekon.*, vol. 05, no. 2, hal. 372–382, 2025, doi: <https://doi.org/10.54209/jasmien.v5i02.890>.
12. Y. Putra dan Furqan, "INTEGRATING RENEWABLE ENERGY AND SMART GRID SYSTEMS: A PATHWAY TO CARBON-NEUTRAL COMMUNITIES IN SOUTHEAST ASIA," *IJOMRAL Int. J. Multidisciplinary Res. Lit.*, vol. 5, no. 1, hal. 1–12, 2026, doi: <https://doi.org/10.53067/ijomral.v5i1.395>.
13. Kemenkominfo, *Indeks Literasi Digital Masyarakat Indonesia*. Kominform RI, 2023.
14. Kemenparekraf, *Statistik Pariwisata dan Emisi Karbon*. Kemenparekraf RI, 2023.
15. OECD, *Green Growth and Sustainable Tourism*. OECD Publishing, 2021.
16. R. Dodds dan M. R. Holmes, "Sustainable tourism and policy implementation: Lessons from the Caribbean," *J. Sustain. Tour.*, vol. 28, no. 10, hal. 1595–1612, 2020.
17. B. Bramwell dan B. Lane, "Sustainable tourism: An evolving global approach," *J. Sustain. Tour.*, vol. 19, no. 4–5, hal. 411–424, 2011.
18. W. N. Adger, "Vulnerability," *Glob. Environ. Chang.*, vol. 16, no. 3, hal. 268–281, 2006.
19. C. Folke, "Resilience thinking: Integrating resilience, adaptability, and transformability," *Ecol. Soc.*, vol. 15, no. 4, 2010.
20. S. L. Cutter, "A place-based model for understanding community resilience to natural disasters," *Glob. Environ. Chang.*, vol. 18, no. 4, hal. 598–606, 2008.
21. D. Biggs, "Tourism and resilience: Adapting to social, political, and economic change," *J. Sustain. Tour.*, vol. 20, no. 1, hal. 1–19, 2012.
22. C. M. Hall, "Climate change and sustainable tourism: New vulnerabilities and resilience pathways," *J. Sustain. Tour.*, vol. 23, no. 3, hal. 419–437, 2015.
23. A. A. Lew, "Scale, change and resilience in community tourism planning," *Tour. Geogr.*, vol. 16, no. 1, hal. 14–22, 2014.
24. B. W. Ritchie, "Tourism crisis and disaster management in the age of COVID-19," *J. Travel Res.*, vol. 60, no. 4, hal. 889–903, 2021.
25. R. Dodds dan R. Butler, "Ongoing evolution of sustainable tourism policies," *J. Sustain. Tour.*, vol. 27, no. 7, hal. 1027–1043, 2019.
26. B. Lane, "Sustainable rural tourism strategies," *J. Sustain. Tour.*, vol. 17, no. 6, hal. 783–795, 2009.
27. S. Gössling dan C. M. Hall, "Tourism and global environmental change," *Routledge*, 2006.
28. R. Buckley, "Sustainable tourism: Research and reality," *Ann. Tour. Res.*, vol. 39, no. 2, hal. 528–546, 2012.
29. B. Bramwell dan B. Lane, "Sustainable tourism: Progress, tensions, and opportunities," *J. Sustain. Tour.*, vol. 21, no. 4, hal. 459–477, 2013.
30. UNWTO, "Sustainable Tourism Guidelines for Developing Regions." 2023.

31. F. Higgins-Desbiolles, "Sustainable tourism: Sustaining tourism or something more?," *Tour. Manag. Perspect.*, vol. 25, hal. 157–160, 2018.
32. T. Mihalic, "Sustainable-responsible tourism discourse," *Tour. Rev.*, vol. 71, no. 1, hal. 1–21, 2016.
33. UNWTO, "Sustainable tourism guidelines for small communities." 2022.
34. K. Hughes, "Tourism and environmental sustainability," *J. Sustain. Tour.*, vol. 27, no. 5, hal. 629–646, 2019.
35. U. Gretzel, "Digital tourism: An overview of smart technologies," *Tour. Manag. Perspect.*, vol. 40, hal. 100857, 2021.
36. M. Sigala, "Social media and the co-creation of tourism experiences," *Curr. Issues Tour.*, vol. 21, no. 2, hal. 134–153, 2018.
37. F. Femenia-Serra dan U. Gretzel, "Influence of artificial intelligence on tourism: A global perspective," *Tour. Rev.*, vol. 75, no. 3, hal. 517–536, 2020.
38. D. Buhalis dan A. Amaranggana, "Smart tourism destinations," in *Information and Communication Technologies in Tourism*, 2015, hal. 553–564.
39. Y. Li, "Big data and smart tourism: A framework for sustainable development," *J. Destin. Mark. Manag.*, vol. 8, hal. 285–296, 2018.
40. M. H. Harefa, Y. Putra, B. Asdilvira, dan Furqan, "Impact Of Destination Management Organization On The Development Of Sugihen Tourism Village," *Int. J. Econ. Manag.*, vol. 03, no. 01, hal. 48–53, 2025, doi: <https://doi.org/10.54209/iem.v3i01.63> Impact.
41. B. Neuhofer, "Smart technologies for personalized experiences," *Tour. Manag.*, vol. 48, hal. 140–151, 2015.
42. B. Neuhofer, "Smart tourism experiences: The future of tourism innovation," *J. Travel Res.*, vol. 60, no. 4, hal. 682–698, 2021.
43. Z. Xiang dan D. R. Fesenmaier, "Big data analytics in tourism," *Tour. Manag.*, vol. 58, hal. 147–160, 2017.
44. M. M. Mariani, "Tourism and digital ecosystems: A systematic literature review," *J. Bus. Res.*, vol. 141, hal. 185–197, 2022.
45. S. Gössling dan C. M. Hall, "Sustainable tourism transformation: A discussion of governance problems," *J. Sustain. Tour.*, vol. 27, no. 1, hal. 1–17, 2019.
46. P. Brouder, "Tourism and resilience: Transforming people and places," *Tour. Geogr.*, vol. 19, no. 5, hal. 567–573, 2017.
47. S. Becken dan J. E. Hay, "Climate change and tourism: From policy to practice." 2012.
48. L. Huang dan Y. Liu, "Digital innovation and sustainable tourism development," *Sustainability*, vol. 12, no. 21, hal. 8913, 2020.
49. M. Sigala dan U. Gretzel, "Advances in social media for travel, tourism, and hospitality," *Routledge*, 2018.
50. S. Gössling, "Digital transformations in tourism and sustainability," *J. Sustain. Tour.*, vol. 29, no. 5, hal. 1–18, 2021.
51. C. Chang, "Digital innovation and sustainable development in rural tourism," *Sustainability*, vol. 13, no. 10, hal. 5527, 2021.
52. M. Sigala, "Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research," *J. Bus. Res.*, vol. 117, hal. 312–321, 2020.
53. D. B. Weaver, *Sustainable tourism: Theory and practice*. Routledge, 2011.
54. C. Koo, "Smart tourism: Traveler, business, and destination perspectives," *Sustainability*, vol. 11, no. 6, hal. 1494, 2019.
55. A. R. A. Wicaksono, E. L. Ray, dan B. G. Prakosa, "The Influence of Brand Activism on Consumer Loyalty and Social Change," *Society*, vol. 13, no. 2, hal. 725–740, 2025, doi: [10.33019/society.v13i2.841](https://doi.org/10.33019/society.v13i2.841).

56. B. Mesra, E. D. Surya, dan M. S. Asman, "The Impact of Customer Engagement on Loyalty Toward Halal Products : Mediating Role of Satisfaction," *Society*, vol. 12, no. 2, hal. 631–642, 2024, doi: 10.33019/society.v12i2.709.