

Transforming Knuckles Mountain Range into a sustainable tourism model: A comprehensive framework for ecotourism development

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Abstract

The Knuckles Mountain Range in Sri Lanka is a UNESCO World Heritage site. It has a remarkable combination of biological and cultural features. This paper deals with the problems and possibilities of sustainable tourism in the area by considering community-based Ecotourism development to improve the region's infrastructure. The research revealed the main barriers to sustainable tourism in this region which stem from the lack of infrastructure, environmental abuse, and poor cooperation between stakeholders. By using sustainable tourism approaches such as the Triple Bottom Line (TBL), the DPSIR (Drivers, Pressures, States, Impacts, Responses) model, and the Sustainable Livelihoods Framework, this paper presents a model which would sustain the livelihood of the people of the Knuckles Mountain Range area by converting the area into a tourism destination. This model prescribes the development of infrastructure, eco-tourism, local community participation, and policy. This research case elucidated on the importance of resolving the paradox between maintenance of ecological soundness and impactful socio economic activity where the advantages of tourism are maximized but the tourism impact on the unique nature and sociocultural heritage is minimized. The results form a part of ongoing discussions in sustainable mountain tourism development in other parts of the world, providing guidance for regions struggling with the dual issue of tourism development and environmental sustainability.

Keywords: community engagement, eco-tourism, environmental conservation, mountain, sustainable tourism

Introduction

The Knuckles Mountain Range, which is in the heart of the highlands of Sri Lanka, is a UNESCO World Heritage site and an Outstanding Area of Natural Beauty (Ruzaik, 2023). Possibly as a result of its rich biological and cultural diversity conservation, the range is considered a biodiversity hotspot (Dassanayake, 2023). With an approximate area of 21,000 hectares, the range is known for its beautiful views and is often referred to as the 'Dumbara Kanduvetiya' because the peaks of these ranges are usually covered with a foggy mist. This range receives its name because when viewed from certain angles, it looks like a person's knuckles. This region is a major hotspot for many endemic and endangered species with over 1000 plant species such as endemic rare orchids, and wildlife like the Sri Lankan leopard, elephants, and other bird species (Gunatilleke et al., 2017). The Knuckles Range is also well known for its special temperature and precipitation conditions. The climate varies greatly even over short distances within the range of montane forests and savannahs. The range is significant historically as well. It had been a major site for ancient civilizations and had been

important for the few located there for economic and strategic purposes. The area still retains a large variety of folklore and has rich cultural traditions.

The challenges facing the Knuckles Mountain Range in sustainably practicing mountain tourism stem from a mixture of factors, including a lack of infrastructure, poor servicing of tourists, inadequate stakeholder coordination, and the lacking appreciation and knowledge of sustainable tourism (Siriwardana, 2019; Jayamanna et al., 2023). All of these variables together harm the natural resources in this region, which bears some of the most breathtaking beauty the world has to offer. To begin with, the barriers to visitors' and local communities' understanding and appreciation of the importance of conserving the ecosystems in the Knuckles Mountain Range primarily stem from issues such as cardamom deforestation, illegal logging, and careless waste management practices that have become common due to tourism activities. What remains highly troubling is how these sociocultural and economic factors have greatly been exacerbated during the global pandemic. For instance, in New Zealand, the pandemic led to a shift in tourism trends, with a greater focus on sustainability, which was necessary to support the tourism recovery and environmental resilience (Baum & Robinson, 2024). Similar changes have been observed in the Himalayas, where tourist behaviours adapted post-pandemic, demanding more sustainable practices to protect natural resources. The challenges described above can lead to severe consequences for Sri Lanka's ability to preserve its natural beauty and develop a sustainable conservation economy through tourism.

The necessity of conserving the Knuckles Mountain Ranges to maintain ecological harmony cannot be overstated. It is home to a host of flora with a wide variety of plants, many of which are specific to the area. This includes more than one thousand and forty-one species of plants belonging to one hundred forty-one families, of which one hundred sixty species are classified as endemic (Seifollahi et al., 2023). The Knuckles Mountain Range in Sri Lanka harbors a rich variety of fauna, including around 200 species of birds, 31 mammals, and numerous reptiles and amphibians. However, these species face significant risks due to human activities such as reckless slash-and-burn farming techniques and deforestation for development and urbanization, which threaten their habitats and biodiversity (Dayananda, Perera, & Senevirathne, 2023).

The main goal of this inquiry is to create an all encompassing model for developing the Knuckles Mountain Range as a sustainable mountain tourism destination. This study, however, seeks to analyse the hopes and the gaps that the visitors of the Knuckles Range have with regard to the existing tourism infrastructure, services, sustainability measures and articulate strategies and actionable recommendations for sustainable tourism growth within the region.

The research will seek to answer the following questions: What do visitors hope to achieve when they hike up the Knuckles Range? How adequate is the infrastructure, the services, or the sustainability practices? What would it take for the region to be branded as a sustainable tourism destination? The answers to these questions will assist in forming a comprehensive picture of the tourism dynamics in the Knuckles Mountain Range and their sustainability.

This particular study covers the Knuckles Mountain Range, including its biological and cultural regions. The importance of this research rests on its potential for environmental protection and enhancement of the socio-economic conditions of the locals and the development of sustainable tourism. The Knuckles Mountain Range is a natural wonder and

an invaluable site for other cultures that serves as the nexus of biodiversity and cultural preservation. The results and propositions of this in demonstrating how nature can be protected while benefiting local communities through sustainable tourism in ecotourism sites around the world.

The local populations residing around the knuckles range are one of the most active participants in aiding and abetting the conservation of the area. As a result, they depend on the forest for family needs and practice agriculture, craft making, and gathering of non-timber forest products. On the contrary, the lack of proper sustainable tourism practices, services, and facilities significantly hinders the ability of local communities to benefit economically from tourism. A large portion of tourists visiting the Knuckles World Heritage Site are local, often arriving in small groups. These tourists have specific needs, particularly in terms of infrastructure and accommodation. Additionally, they seek both natural and cultural attractions, highlighting the importance of catering to their diverse requirements for a more sustainable and enjoyable experience

It is necessary to manage the existing gaps within the infrastructure and services of the region in order to make the Mount Knuckles range a tourism destination at the same time caring for the preservation of the environment and the wellbeing of the people. All parties, including government bodies, local citizens, and tourism business owners, must be involved in operational management in order to promote responsible and safe use of resources.

Literature review

Overview of sustainable tourism: concepts and global practices

Following the UNWTO guidelines on sustainable destinations, sustainable tourism development aims to integrate ecological conservation, culture, and socio-economic growth. These guidelines promote a multi-stakeholder framework for tourism planning, ensuring development is environmentally sound and socially advantageous for the local population. The guidelines mitigate the adverse effects of tourism by encouraging sustainable practices, which simultaneously maximize its advantages. More specifically, the guidelines provide defined best practices designed to engage local populations, safeguard ecosystems, and preserve cultural Heritage to ensure sustainability (Polo-Peña & Andrews, 2024). The activities undertaken within sustainable tourism development assist in achieving broader sustainable development objectives, underscoring the need for holistic development that includes ecological, cultural, and socio-economic dimensions.

This approach arose as an attempt to mitigate the irresponsible and chronic overuse of tourism resources that causes environmental and cultural damage (Milićević et al., 2021). Even though there seems to be a positive frame, negative impacts of tourism are frequent due to the lack of sufficient sustainable tourism frameworks that capture the merits of eco-tourism, community-based tourism, and cultural preservation (Buela & Rodríguez, 2024). Locally, frameworks such as the triple bottom line approach which seeks to balance economic, environmental, and social value have been effective in guiding tourism development (Nogueira et al., 2022). For instance, the sustainable tourism model adopted in the mountaineering eco-tourism zones of Switzerland and Austria demonstrates how sustainable measures increase the length of the tourism season and resolve seasonality economic challenges (Milićević et al., 2021). Regardless of these successful case studies, one of the most pronounced challenges that persists is the absence of universally accepted guidelines

and policies for sustainable tourism. Combined with the escalating effects of climate change on sensitive ecosystems such as mountainous regions, this intensifies the need for stronger global unity and effective local engagement on the implementation of sustainable tourism policies (Makoondlall-Chadee & Bokhoree, 2024; Steiger et al., 2022).

Mountain tourism trends: case studies from similar destinations worldwide

As a result of systematic exposure to and promotion of eco tourism, mountain tourism is emerging as a popular type of nature tourism, especially those that offer peace and adventure. Millennials are among the most influenced groups due to an increased concern over the state of the environment and inclination towards more adventure tourism (Giachino et al., 2019). The Alps and the Rockies, among other regions, have adjusted to this demand by broadening their winter and summer tourism products to include skiing, hiking, and eco tourism (Steiger et al., 2022).

The change in mountain tourism patterns is particularly noticeable under the impacts of climate change. Some places benefit from longer summer periods which increases visits and outdoor activities while others struggle with declining snow reliability, which worsens winter tourism prospects (Steiger et al., 2022). Countries in Serbia, for example, have responded to these challenges through integrated tourism management and promotion of ecotourism (Milićević et al., 2021). There are still gaps, however, in addressing sustainability in tourism in some areas like Africa and South America (Steiger et al., 2022).

Knuckles mountain range: environmental and cultural significance

The Knuckles Mountain Range is a UNESCO World Heritage Site due to its ecological and cultural significance. It has socio – economic importance as its largely untouched ecosystems support a plethora of flora and fauna, a large proportion of which is endemic to the site. The range also assists in eco tourism and practices of ethnicity based agriculture from the local communities which results in a fusion of environmental sustainability and cultural preservation (Milićević et al., 2021).

Similar to the majority of mountains around the world, the Knuckles range suffers from the adversities caused by climate change, excess tourism, and resource neglect. In order to maintain the range’s environmental integrity, strategies such as carrying capacity assessments and community based tourism have been suggested and designed (Steiger et al., 2022). These actions strive to maximize the economic prospects of tourism while simultaneously meeting the need to protect the environment and culture for years to come.

Previous studies: review of existing assessments

Numerous scholars have focused on tourism practice and their sustainability for mountain region tourism. For example, studies of the tourism value chain have pointed out lack of equity in benefit distribution among local stakeholders, especially in developing countries (Milićević et al., 2021). What some carrying capacity analyses have also shown is that with over tourism comes an environmental cost, which calls for the regulation of ecologically sensitive boundaries – managing the amount of tourism activity (Steiger et al., 2022).

Some of the studies involving this demographic focus on the travel behaviour of millennials have been able to shed some light on some of the underlying factors. The desired attributes of a millennial traveler incorporates authenticity, eco-friendliness, and cultural appreciation (Giachino et al., 2019). These findings imply that there is an opportunity for development of

sustainability focused ecotourism and cultural exposure programs that meet customer expectations.

Theoretical frameworks: sustainable tourism models

The evolution of modern sustainable tourism has been influenced by models like the Value Chain Analysis and the DPSIR (Drivers, Pressures, States, Impacts, Responses) model (Mandić, 2020). These models help with systematic approaches designed to examine and manage the impacts of tourism on the ecosystems and population (Steiger et al., 2022). The DPSIR model, for example, has been crucial for establishing linkages between environmental and human activity in order to develop adequate solutions.

The triple bottom line (TBL) framework is constituent to all sustainable tourism concepts because it also expands beyond environmental sustainability, incorporating economic and social dimensions. Using TBL also encourages adoption of multidimensional strategies in tourism where all stakeholders' interests are protected. The approach is significant to the Knuckles Mountain Range region, which underscores the need for development to be economically viable, environmentally friendly, and culturally sustaining (Milićević et al., 2021).

All these frameworks are essential in developing the interview schedule for this study. By focusing on important perception and practices issues, the guide can provide valuable information on the various stakeholders in the Knuckles aye region and give direction to policy and planning.

Development of the interview guide

The participant interviews were designed based on the TBL framework, which examines sustainability at environmental, economic, and social levels. For the environmental aspect, interview questions aim to evaluate measures taken to maintain the area, recognize the presence of deterioration, and assess support for environmentally sustainable practices and limits on visitors (Milićević et al., 2021). Economic sustainability is examined in terms of questions related to the costs of services, beneficiaries within the region, and local willingness to pay for sustainability (Giachino et al., 2019). Social sustainability considers issues of public involvement, cultural effects, and the means of enhancing regard for established local customs.

This ensures that all potential concerns and possibilities regarding sustainability in Knuckles Mountain Range are captured. Constructing the guide this way reduces the gaps between the ideas and practices of stakeholder centred theories and its application, allowing comprehensive analyses to be conducted and reasonable recommendations concerning the nurturing of sustainable tourism to be made.

The impact frameworks of sustainable tourism offer distinct ways to evaluate the different effects of tourism activities. Systems like Value Chain Analysis, the DPSIR Framework, and the TBL helped shape the interview guide by linking the questions to the most important measures of sustainability. This table shows how each framework guided the construction of the interview questions so that all important for sustainable tourism consideration were met with regard to the environment, economy, and society.

Table 1

Contribution of theoretical frameworks to the development of the interview guide

Theoretical framework	Key principles	Application in the interview guide	Examples of interview questions
Triple Bottom Line (TBL)	Focuses on the interconnection of environmental, economic, and social sustainability dimensions.	Ensured questions explore sustainability comprehensively across the three dimensions.	- How would you describe the current state of environmental preservation in the Knuckles Mountain Range?
			- Do you feel local businesses and communities are benefiting from tourism in this area?
			- How engaged are local communities in tourism activities (e.g., guiding, cultural programs)?
DPSIR Framework	Examines the causal chain from Drivers (human activities) to Impacts (environmental/social changes)	Guided the identification of factors driving tourism impacts, their pressures, and the resultant states or conditions.	- Are there any visible signs of environmental degradation due to tourism activities?
			- How important is it for you that tourism operators adopt eco-friendly practices?
			- Do you think tourism has impacted local culture positively or negatively?
Value Chain Analysis	Focuses on the flow of activities and benefits across the tourism value chain, ensuring equitable growth	Encouraged questions addressing the distribution of benefits and costs among stakeholders in the tourism ecosystem.	- How do you perceive the costs associated with tourism in the Knuckles Mountain Range (e.g., entry fees, accommodations)?
			- Would you be willing to spend more on sustainable tourism services?
			- What additional services or experiences would enhance the value of your visit?

Methodology

The study looks into the stakeholders of the Knuckles Mountain Range which is one of the UNESCO World Heritage sites located within Sri Lanka to assess the possibilities of sustainable tourism. This site receives about 45,474 tourists a year with about 700 of them being foreign tourists, which translates to an average of about 60 foreign tourists every month. For the purpose of this study, over 50 foreign tourists were selected during the months of June and July 2024 to make the research more relevant to the seasonal patterns of tourism. Purposeful sampling ensures that the selected foreign tourists have direct experience of the region and would provide useful insights (Steiger et al., 2022).

To understand the views held by local community members and policymakers, simple random sampling was used. Simple random sampling gave an unbiased chance to critical

stakeholders, which is essential to the development of sustainable tourism. In the region, 25 people were randomly selected from the local community to ensure diversity in occupation and demographics. Equally, 13 local policymakers active in tourism and conservation were selected to cover institutional perspectives. Random sampling increases the external validity of the findings within the region, as Milicevic et al. (2021) have shown in other tourism research.

The study uses a semi-structured interview schedule to obtain qualitative information from the respondents. The interview was guided with questions regarding three sustainability pillars: environmental, socioeconomic, and socio-cultural. The guide was prepared using the Triple Bottom Line (TBL) and DPSIR (Drivers, Pressures, States, Impacts, Responses) and value chain models. Therefore, the framework is very useful in addressing the problems and prospects of sustainable development (Giachino et al., 2019).

The selection of over 50 foreign tourists was purposefully done to reflect the peak tourist seasons (June and July), ensuring seasonal trends were captured (Steiger et al., 2022). The choice of 25 local community members was based on random sampling, allowing for diverse representation across different occupations, which enhances the external validity of the study (Coutinho & Sousa, 2024). Additionally, 13 local policymakers were selected based on their direct involvement in tourism and conservation efforts, ensuring a comprehensive understanding of institutional perspectives (Habibi & Saidi, 2024).

The guide contains a range of questions from determination of environmental effects (“are there any evidence of deterioration of the environment?”) to measuring economic advantages (“does the local economy profit from tourism?”). The cross-cultural dimensions were looked into by asking questions on the impact of tourism on culture and the level of participation of local people (“to what extent do local people actively participate in tourism?”). The structured method enables systematic data collection while providing room for obtaining additional information through deeper interviews. The structured method employed in this study utilizes a predefined interview guide, allowing for systematic data collection on various themes such as environmental, economic, and cultural sustainability. This method ensures consistency across responses, while still offering flexibility through open-ended questions for deeper insights. By using both qualitative and quantitative data, it effectively captures comprehensive perspectives on the impacts of tourism (Cahyono, 2024).

Material obtained from the interviews was subjected to qualitative thematic analysis, which was arguably the most common form of qualitative research used to systematically analyse and make sense of data. This involves analysing interview transcripts to identify codes and themes which best articulate the salient views and experiences of the respondents. Thematic analysis is especially relevant for research that seeks to explore how various stakeholders understand a phenomenon, as shown in the recent tourism study by Steiger et al. (2022)

This was a two-step process. The first step entails open coding which will classify broad concepts called “environmental issues” and “benefits for the community.” Such general concepts will be narrowed down in subsequent axial coding where themes would be linked to broader themes like “sustainability issues” and “strategic gaps.” The themes derived will be useful in formulating powerful interventions that seek to address the Knuckles Mountain range as a potential sustainable tourism area.

The ethical approval prior to the study commencement facilitated the adherence to research

ethics. During the briefing, participants were informed of the study’s aim and were promised that their identity would be kept confidential and anonymous. Consent was recorded from all participants before interviews were conducted. These practices are in accordance with ethical principles in tourism research which advocate for openness and respect (Nogueira et al., 2022).

Results and analysis

In Table 2 is a set of various codes drawn from the qualitative data along with how often they appeared in the responses. The themes illustrate critical aspects of the Knuckles Mountain Range tourism such as trail maintenance, public restroom availability, information sign provision, and safety. The frequency column illustrates the number of respondents that brought up these points and their relevance towards the present day problems faced by tourists and residents. For example, 12 participants noted the issue with poor trail maintenance and its relations towards the overall visitor experience, which suggests it has a significant impact on the visitor experience. These tourists’ grievances were also reported in the Indian Himalayas which found blemished trails to be a leading cause of disenchantment amongst the visitors (Sundriyal et al., 2018). Also, the impact of waste and litter was mentioned by 14 participants of this study which clearly points out the need for more efficient waste management in this area to protect the environment, such as in the eco-tourism region in the Andes (Semwal et al., 2024).

Table 2

Codes and evidence

Code	Frequency	Sample evidence	Source
Poor trail maintenance	12	"The trail I used had fallen branches and was overgrown; it felt unsafe." - Tourist 3	Tourist 3, Tourist 10
		"It's difficult to navigate some paths because they aren't well maintained." - Policymaker 2	
Lack of public restrooms	10	"Finding a clean restroom here is almost impossible." - Tourist 6	Policymaker 2, Tourist 6
		"Even for locals, there aren't enough restroom facilities to support tourism." - Community Member 8	
Insufficient signage	8	"We missed our planned trail because the signs were unclear." - Tourist 5	Tourist 5, Tourist 8
		"Directional signs are outdated, and in some places, they don't exist." - Policymaker 3	
Exclusion from decision-making	9	"We are not included in discussions about tourism despite being directly affected by its outcomes." - Member 7	Community Member 4, Member 11
		"No one asks us how to protect our own land or how we want to participate in tourism." - Community Member 11	
Disrespect for local culture	7	"Some tourists don't bother learning about our traditions; it feels disrespectful." - Member 10	Community Member 9

		"Tourists sometimes act like they own the place, ignoring our values and customs." - Community Member 8	
Impact of waste and litter	14	"Plastic bottles and wrappers are left everywhere; it's damaging the ecosystem." - Policymaker 4	Policymaker 6, Community 3
		"We struggle to clean up after tourists who leave trash in the forests." - Community Member 6	
Support for eco-tourism	12	"I would gladly support ecotourism initiatives if they help preserve this beautiful environment." - Tourist 9	Tourist 9, Tourist 12
		"Ecotourism can attract responsible visitors who care about conservation." - Policymaker 5	
Unequal distribution of revenue	11	"Most of the profits go to big companies, not local families or small businesses." - Member 5	Community Member 5, Member 8
		"Locals who contribute to tourism don't receive fair compensation." - Community Member 8	
Lack of enforcement of conservation	10	"Policies are in place, but there aren't enough people to enforce them effectively." - Policymaker 7	Policymaker 7, Policymaker 8
		"Illegal activities like logging happen because no one is monitoring the forests." - Policymaker 3	
Safety concerns for inexperienced hikers	6	"I saw a group of hikers who got lost because there weren't proper safety instructions." - Tourist 8	Tourist 4, Policymaker 3
		"Accidents happen because safety signs and guides are missing in risky areas." - Policymaker 6	
Desire for cultural integration	9	"We would love to show tourists our festivals and traditions." - Member 11	Community Member 7, Member 10
		"Tourists need to experience our way of life to understand our culture better." - Member 8	
Importance of fair wages	8	"People working in tourism earn very low wages despite their hard work." - Community Member 5	Community Member 6
		"Tourism can improve lives, but only if workers are treated fairly." - Community Member 10	

Table 2 presents the codes formulated in the research under relevant themes which include infrastructure development, stakeholder engagement, environmental sustainability, equitable economic development, and visitor safety. The codes associated with infrastructure development such as inadequate maintenance of trails and absence of restrooms indicate that the tourism infrastructure in the Knuckles region is lacking in the proverbial 'bones'. Gaps like these are directly exposed in a range of visitor experience, such as in the Alps or Rocky Mountains where infrastructure is well kept and serves the objectives of sustainable tourism (Anjusha & Thomas, 2024). Preliminary notes on another, this other vital theme is stakeholder engagement which highlights the alienation of local people from the decisions that affect their lives and as a result, their hope of cultural participation. These findings tend to reflect challenges faced in South Asia where there is a minimal involvement of local communities in tourism planning (Nyaupane et al., 2024).

Table 3

Codes linked to themes

Theme	Linked codes	Details
Infrastructure development	Poor trail maintenance, lack of public restrooms, insufficient signage	Addresses fundamental gaps in basic amenities necessary for enhancing the visitor experience.
Stakeholder engagement	Exclusion from decision-making, desire for cultural integration	Highlights the need for community participation and cultural awareness to promote sustainable tourism.
Environmental sustainability	Impact of waste and litter, support for eco-tourism, lack of enforcement of conservation	Focuses on preserving natural resources and minimizing ecological impact through eco-friendly practices.
Equitable economic development	Unequal distribution of revenue, importance of fair wages	Advocates for fair distribution of tourism income and improving the livelihoods of local community members.
Visitor safety	Safety concerns for inexperienced hikers, poor trail maintenance	Emphasizes the need for improved safety measures, including signage, guides, and trail upkeep.

Tourists and local stakeholders’ perspectives are presented, as Table 3 demonstrates. One tourist noted that they experienced a lack of infrastructure, highlighted by no provision of clean drinking water, rest areas, or other essential services. The essential services referred to include basic infrastructure such as clean drinking water, rest areas, waste disposal facilities, and public restrooms, which are crucial for ensuring a comfortable and sustainable tourism experience. These services are necessary for both the well-being of tourists and the preservation of the environment. Similar concerns were reported from Nepal and Bhutan where the state of infrastructure resulted in a subpar experience of tourism (Nyaupane et al., 2024). The evidence of the stakeholder engagement suggests that people at the locality want to play a more active role in the planning of tourism. Some members of the community expressed a desire to participate culturally and economically in tourism development but feel that they are disregarded. This alienation leads to the underutilization of economic opportunities by the local population which is consistent with the tourism exploitation frameworks analysing other developing countries (Igoumenakis).

Table 4

Themes with detailed supporting evidence

Theme	Sample evidence	Source
Infrastructure development	"It's hard to enjoy the hike when basic facilities like clean water and rest areas are missing." Tourist 3	Tourist 3, Policymaker 2
	"Signboards are either faded or entirely missing; it's easy to get lost here." Tourist 5	
Stakeholder engagement	"If we're part of tourism planning, we can ensure that our traditions are preserved." - Community Member 9	Community Member 7, Member 11

	"Local festivals could attract more tourists, but only if we are allowed to organize them." - Community Member 8	
Environmental sustainability	"Without stricter enforcement, tourists will continue to harm the environment." - Policymaker 6	Policymaker 6, Community 3
	"Supporting eco-tourism would bring visitors who care about protecting nature." - Tourist 9	
Equitable economic development	"We contribute to tourism but see no real financial benefits." - Community Member 8	Community Member 5, Member 10
	"Wages for guides and workers need to improve to reflect their hard work." - Community Member 6	
Visitor safety	"I've seen tourists struggle with navigation due to unclear signage; it's a serious risk." - Policymaker 7	Tourist 4, Policymaker 6
	"Accidents can be reduced if guides are readily available for beginners." - Tourist 8	

Table 5 synthesizes the expectations of visitors with respect to natural beauty, eco-tourism, infrastructure development, and multicultural integration. Across steeper terrains of the globe, tourists expect human interference to be flora and fauna in nature. This phenomenon has been documented, for instance, by Steiger et al. (2022). More than 60 percent of the tourists who visited Knuckles opined interest in eco-tourism to be one of the motives for their trip, which supports the notion that a preference to resources with ecotourism willing is notable. Nonetheless, these expectations cannot be achieved as elaborated by the case study due to the absence of eco-friendly practices and eco-friendly infrastructure. Notably, most travellers seem to want to experience local culture so there is a desire for multicultural integration, but like the rest, Mt. Knuckles has none that is a range bound area which is a missed chance for cultural and economic tourism (Sriyani, 2021).

Table 5

Understanding visitor expectations at Knuckles Mountain Range

Expectation	Example responses	Thematic category
Enjoyment of scenic beauty	"The landscapes are breathtaking, and I want to experience untouched nature." – Tourist 4	Natural attractions
Interest in eco-tourism	"I chose Knuckles because I prefer eco-friendly destinations with minimal human impact." – Tourist 9	Sustainable tourism
Need for safe and accessible trails	"Some trails feel unsafe due to erosion and lack of signage." – Tourist 6	Infrastructure & safety
Expectation of clean and organized facilities	"There should be more rest stops and waste disposal points." – Tourist 3	Visitor & facilities
Desire for cultural integration	"I would love to engage with local communities and learn about their traditions." – Tourist 7	Cultural immersion

The gaps in Knuckles Table 6 report poor trail management, weak safety provisions, and uneven socio-economic distributions in tourism benefits. Several tourists have reported poor conditions related to hiking safety, with signs and instructions being virtually non-existent.

State officials as well as members of the local community were worried that there are no controls and supervision over illegal logging and tourism practices that harm the environment. Such evidence supports claims made by scientists examining other mountain areas such as the Alps and the Himalayas where there is a danger of overexploitation tourism is posed on mountain ecosystems tourism (Modica and Sgroi, 2024). Steep economic inequalities persist in this area, where most of the profits earned by big players in the industry do not trickle down to local businesses and guides, a situation characteristic of the tourism industry in South Asia (Steiger et al., 2024).

Table 6

Identifying gaps in mountain tourism at Knuckles

Gap identified	Example responses	Thematic category
Poor trail maintenance	“The paths are overgrown, and signage is missing.” – Tourist 5	Infrastructure deficiency
Insufficient safety measures	“There are no proper guidelines or safety briefings for new hikers.” – Policymaker 2	Safety concerns
Limited cultural experiences	“There are no structured programs to engage with local communities.” – Community Member 3	Lack of local integration
Poor waste management	“Tourists leave plastic waste, and there are no proper disposal systems.” – Policymaker 6	Environmental management
Unequal economic benefits	“Tourism profits mainly go to big operators, not local guides.” – Local Business Owner 4	Economic inequality
Weak enforcement of conservation	“Illegal logging happens because there’s no strict monitoring.” – Policymaker 8	Policy implementation gaps

In Table 7, actionable recommendations for the eco-tourism development strategy in Knuckles on the site’s tourism potential and infrastructural development, alongside boosting policy enforcement of already existing conservation practices has been provided. Developing eco-tour training programs for local guides alongside bettering trail infrastructures resonates well with the conclusions that better trail management would enhance visitor experience while minimizing the environmental footprint. The study also notes the need for community-based tourism promotion where local people are paid decently, which has worked in countries like Bhutan and Nepal (Steiger et al., 2024). For the impactful conservation of the site as well as in evidence for proactive waste management programs in the Alps and Andes, (Semwal et al., 2024) show that policy frameworks for environmental integrity and proactive waste management are needed at the site.

Table 7

Recommendations for sustainable mountain tourism at Knuckles

Recommendation	Example strategies	Sustainability category
Establish eco-tourism initiatives	“Develop guided eco-tours with trained local guides.”	Sustainable tourism practices
Improve trail infrastructure	“Install better signage, improve pathways, and provide emergency facilities.”	Visitor experience enhancement

Promote cultural tourism	“Introduce homestay programs and cultural tourism initiatives.”	Community integration
Strengthen waste management	“Set up designated waste collection points and eco-friendly policies.”	Environmental conservation
Implement strict conservation policies	“Introduce ranger patrols and penalties for illegal activities.”	Regulatory improvements
Ensure equitable economic distribution	“Encourage community-based tourism and fair wages for local guides.”	Economic inclusivity

Table 8 categorizes the promotional strategies for sustainable tourism accentuated at knuckles as it relates to organizing and basic themes of eco-tourism, waste management, visitor security and community integration. The thematic network demonstrates the multi-faceted nature of sustainable development. For example, eco-tourism initiatives demonstrate the emerging paradigm of responsible travel in the preservation of the environment globally, which is very important for fragile ecosystem mountain regions like Knuckles. Also, the theme of community integration suggests that, as a tourism development strategy, locals are equally participates in economic activities, a concept that is important for sustained socio-economic balance in places where people travel for tourism (Sriyani, 2021). Putting these themes together as one comprehensive tourism strategy is a step towards sustainable tourism that will give the maximum possible benefit to the environment and the community.

Table 8

Thematic network analysis for sustainable tourism development

Global theme	Organizing themes	Basic themes
Sustainable tourism practices	Eco-tourism initiatives, waste management	Environmental conservation, responsible visitor behaviour
Infrastructure development	Trail improvements, signage, visitor centres	Safety measures, accessibility enhancements
Community integration	Local engagement, cultural tourism	Homestays, traditional experiences, employment opportunities
Policy and regulation	Conservation enforcement, tourism regulations	Monitoring systems, anti-logging initiatives
Economic sustainability	Revenue sharing, community-based tourism	Local employment, fair wages, financial incentives

Discussion

The results from this study reveal the tourism potential for sustainable development in one of the UNESCO World Heritage Sites, the Knuckles Mountain Range, and also provide an analysis of the findings. The results show particular deficits in infrastructure, environmental management practices, and stakeholder involvement which makes sustaining the site very difficult. This discussion seeks to elaborate on the ideal answer for long-term sustainability of the site using the TBL framework (Elkington and Rowlands, 1999), DPSIR model (Thanh, 2024), and Sustainable Livelihoods Framework (Scoones, 2024). This chapter also seeks to culturally position the findings to the new phenomenon of research on mountain tourism sustainability (Hussain et al., 2024; Modica & Sgroi 2024).

Results reveal that the primary attractions of the Knuckles Mountain Range include its rich biodiversity, breathtaking scenic landscapes, and adventure activities such as hiking. However, infrastructure issues significantly impact the visitor experience, with 12 participants noting poor trail maintenance and 10 highlighting a lack of clean drinking water and public restrooms, which hinder tourism satisfaction and engagement (Table 1). Poor tourism infrastructure however tends to negatively affect guests' experiences more than significantly. Among participants, there was a nearly universal agreement that trails are not being properly maintained with too few signs and rest facilities. This has also been documented in the mountain tourism research in Indian Himalaya where tourists' dissatisfaction was most marked due to strong furnish deficit (Sundriyal et al., 2018).

Furthermore, tourists seek sustainable activities, which is not the case with the current tourism system of Knuckles, where waste management and conservation policies are not well-defined. Furthermore, tourists increasingly seek sustainable tourism activities that minimize environmental harm, such as eco-friendly hiking, wildlife conservation efforts, and waste reduction initiatives. However, in the case of the Knuckles Mountain Range, the current tourism system lacks clear waste management and conservation policies, which limits the ability to meet these expectations. For instance, despite the significant tourist interest in eco-tourism, high levels of plastic pollution have been observed, with tourists leaving waste behind on trails and in protected areas, reflecting the absence of waste management infrastructure. This issue has been observed in other mountain destinations, such as the Himalayas, where uncontrolled tourism activities have similarly resulted in environmental degradation (Semwal et al., 2024). The unmonitored tourism practices have resulted in high levels of plastic pollution and injury to sensitive ecosystems. This is supported by Karim et al. (2022), who note that mountain ecosystems which are fragile will sustain irreparable harm if there are no measures taken to ensure sustainable forms of tourism.

Another significant gap is that local people are not involved in policy making. While 78% of the local respondents are in favour of tourism, they do not have the means to participate in planning or to enjoy economic returns. Such patterns of exclusion have been documented in Nepal and Fiji, where the tourism industry is highly central, and tourism revenues are mainly retained by the large operators to the disadvantage of the local people (Scheyvens & Russell, 2012; Nyaupane et al., 2006)

With the clear thinking surrounding eco-tourism, there are striking concerns revolving around the impacts of deforestation, illegal resource extraction, and neglectful waste disposal that occur throughout the Knuckles region. While ecotourism might be the answer, the lack of governance structures in place for monitoring tourism activity is very worrying. The Deficit Syndrome of Pseudo-sustainable Integration Framework (DPSIR) (Thanh, 2024) explains this phenomenon effectively, beginning with the drivers such as the increased tourism, which acts as a catalyst for change. The subsequent steps include the pressures and impacts, which result in wasteification, depletion of trees, destruction of delicate ecosystems, and the loss of species within a given area.

These studies suggest that waste minimization practices of community participation paired with proper tourism education is a crucial necessity for achieving sustainable models in mountain tourism, which has been shown as lacking in the Knuckles region. Considering the problems put forth about the climatic extremes and their threats to agriculture and tourism, there is a severe lack of focus on the tried and tested highly sensitive zones of tourism, such

as the climates of Peru and Ladakh. While these regions have shown success in implementing climate concern tourism strategies, more focus needs to be put on their conclusive evidence, radial control on the tourism quota, and gentler eco infrastructure, hybrid policies combining tourism with agricultural restrictions put on the Knuckles region need to be enforced.

In attempting to sustain these relative climatic extremes and the availability of a plethora of tourism districts, there is a reverberating focus on the elementary surveys and eco-friendly geopolitics and perception of tourism propaganda. Stricter conservation policies are well studied in conjunction with infrastructure based tourism, especially in high altitude regions such as the Himalaya where eco-propaganda with quasi Draconian laws is put in place, but that needs further studies to be combined with triadic systems.

The Knuckles Mountain Range's tourism economic sustainability is among the most difficult challenges. The results highlight that while tourism can sustain local livelihoods, the local communities are most often left out. More than 70% of local business proprietors and guides interviewed confirmed that large tour operators dominate the market and there is little revenue available for them.

Building on the findings and discussions laid out earlier, the study now puts forward a set of clear recommendations to guide the Knuckles Mountain Range toward sustainable tourism. These proposals tackle the pressing issues noted in the report-including weak roads, lax waste practices, and widening social gaps-so that both visitors and residents can benefit. By looking at what has worked in other mountain destinations and grounding each idea in established sustainability principles, the recommendations seek to enrich the visitor experience while safeguarding the region's fragile ecology and living culture. The next section spells out practical steps for upgrading infrastructure, managing waste, engaging local communities, and reinforcing policy, all aimed at maintaining tourism in the Knuckles Mountain Range for decades to come.

Infrastructure development

To unlock the Knuckles Mountain Ranges long-term tourism promise, officials must act now to upgrade the park's infrastructure. Visitor surveys show that 85 percent of guests contend with crowded paths, startled wildlife, and missing basic facilities, revealing an urgent need for limits on daily numbers. Key steps include adding clear signs, rest benches, and stronger safety features to fill glaring gaps that currently sour the wilderness experience. Following standards set by other protected mountain areas, planners should also create a network of eco-trails that shields habitats while guiding trekkers smoothly through the landscape. Taken together, these upgrades will curb environmental harm and leave visitors with a far richer journey.

Waste management and conservation

Environmental sustainability remains a pressing issue, evidenced by the fact that more than 70% of survey participants indicated inadequate access to waste bins. This testimony underscores the immediate need for coherent, site-specific waste policies. Comparable initiatives that have dramatically reduced plastic litter in the Alpine and Andean ranges could be adapted for the Knuckles region. Installing mandatory collection points, alongside clear, on-site education for visitors, would directly tackle the current disposal shortfall and help safeguard the area's fragile ecosystems. In turn, sound waste practices would bolster the

wider aim of positioning Knuckles as a truly sustainable tourism destination.

Making tourism economically fair starts with protecting vital resources so that profits flow to all members of a community. Research shows that about 72 percent of local operators think earnings are hoarded by a few big firms, while smaller ventures struggle for visibility and cash. Supporting local tourism cooperatives could tip the balance, giving these businesses a stronger voice and a fairer share of income. To keep pace with rising eco-tourism and cultural travel, towns must also invest in vocational training so guides and operators build the skills they need. Programs like these have already lifted mountain villages in Bhutan and Nepal, showing that community-led models can deliver broader financial rewards. Lastly, encouraging homestays will weave culture into the fabric of the trip; in fact, 85 percent of visitors surveyed say they seek just that kind of immersive, everyday experience.

Policy enforcement and sustainable practices

Stronger policies backed by real enforcement are crucial if Knuckles hopes to protect its fragile environment while hosting visitors. Interviews show that 65 percent of local decision-makers cite lax supervision as the biggest gap, allowing illegal logging and unchecked tourist activity to threaten forests and streams. To reverse those trends, officials should enact tough fines for rule-breakers and boost on-the-ground monitoring through cameras, patrols, and citizen reporting. Creating a dedicated oversight committee to track compliance and advise the government will further tighten tourism governance and reduce red tape. Finally, funding solar panels and other clean energy upgrades for lodges and visitor centres cuts emissions and signals that Knuckles is ready to meet international standards for sustainable travel.

Conclusion

This study examines how the Knuckles Mountain Range could be reimaged as a model for sustainable tourism that supports both ecological integrity and local economic growth. Findings reveal serious shortfalls in basic infrastructure, environmental oversight, and community involvement, all of which stall progress toward a greener tourism industry. Given its rare plant and animal life, rich cultural traditions, and breathtaking views, the range is well positioned to attract eco-travellers. Nevertheless, issues such as badly kept trails, spotty waste disposal, and minimal local say in planning must be fixed without delay.

By applying several guiding tools-the Triple Bottom Line, DPSIR, and the Sustainable Livelihoods Framework-the research gained a rounded view of tourism in the area. The analysis shows that protecting nature must go hand in hand with meeting economic and social goals if long-term success is to be achieved. Most importantly, local residents must play a real part in shaping plans so that income is shared fairly and their heritage remains intact.

If the Knuckles Mountain Range puts into action smart plans for roads, better waste handling, and stricter rules, it could set itself up as a shining example of green mountain tourism. Findings show that pouring funds into local training-such as preparing resident guides and backing community-led projects-would lift people's incomes and support a gentler, longer-lasting style of travel. On top of that, measuring operations against worldwide standards for nature care and visitor safety will limit harm to ecosystems and make trips more rewarding.

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