



Traditional Ecological Knowledge and Sustainable Tourism among Communities Adjacent to Arusha National Park, Tanzania

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Abstract

Traditional Ecological Knowledge (TEK) is increasingly recognized as an important community resource for environmental stewardship and cultural continuity, yet its relationship with Sustainable Tourism remains insufficiently established in protected area destinations. This study examined the relationship between TEK and Sustainable Tourism among communities adjacent to Arusha National Park, Tanzania. Guided by Social Exchange Theory and Cultural Ecology, the study employed a convergent mixed-methods design integrating a cross-sectional survey, semi-structured key-informant interviews, and documentary review. Of the planned 384 survey respondents, 352 provided usable responses, while 15 key informants participated in the qualitative strand. Sustainable Tourism was assessed as a multidimensional composite comprising economic, environmental, and socio-cultural sustainability. Quantitative data were analyzed using descriptive statistics, Pearson correlation, and hierarchical multiple linear regression, while qualitative data were analyzed primarily through thematic analysis. TEK recorded a very high perceived level ($M = 4.48$, $SD = 0.40$) and was positively



associated with Sustainable Tourism ($r = .607$, $p < .001$). The relationship remained positive and significant in the fully specified regression model ($\beta = .208$, $p < .001$) after accounting for the other variables in the analytical model. Qualitative findings contextualized this relationship through environmental stewardship and conservation practices; intergenerational knowledge, cultural heritage and community identity; wildlife coexistence and livelihood tensions; and stakeholder collaboration. The findings indicate that TEK is an important community resource associated with tourism sustainability, particularly through environmental stewardship and socio-cultural continuity, although its contribution is shaped by livelihood and institutional conditions. Protected area tourism and conservation institutions should therefore strengthen culturally appropriate recognition of community ecological knowledge while safeguarding community ownership and addressing conservation related livelihood costs.

Keywords: Traditional Ecological Knowledge, Sustainable Tourism, Cultural Ecology, Social Exchange Theory, Community Participation, Protected Areas, Tanzania

Introduction

Sustainable Tourism requires destinations to maintain economic benefits while protecting environmental resources and socio-cultural values (Hardy et al., 2002; Pforr, 2001; Sharpley, 2020; World Commission on Environment and Development [WCED], 1987). This challenge is particularly pronounced around protected areas, where biodiversity conservation, tourism activity, community livelihoods, and cultural landscapes occupy the same geographical space. International tourism frameworks similarly emphasize environmental conservation, economic viability, cultural integrity, and community participation as core elements of destination sustainability (World Tourism Organization [UNWTO], 2004, 2023).

While national parks protect biodiversity and support tourism related livelihoods, neighboring communities may also face restricted access to natural resources, human–wildlife conflict, and unequal tourism benefits (Nyaupane et al., 2022; Snyder & Sulle, 2011). Such experiences can influence residents' support for tourism and conservation. Social Exchange Theory suggests that community support is more likely when perceived benefits outweigh associated costs (Nunkoo & Gursoy, 2012). Sustainable protected area tourism therefore depends not only on conservation institutions but also on meaningful community participation and recognition of locally grounded environmental knowledge.

Traditional Ecological Knowledge (TEK) comprises knowledge, practices, values, and resource-management approaches developed through



long-term interaction with local environments and transmitted across generations (Berkes, 2017). It includes knowledge of wildlife and plants, seasonal change, water and grazing resources, customary conservation practices, and culturally significant landscapes. Across Africa, TEK continues to support biodiversity conservation and resource stewardship, although social, economic, and environmental change increasingly affects its use and transmission (Sinthumule, 2023).

TEK is especially relevant in East African pastoral and protected-area settings. Among Maasai communities in northern Tanzania, Indigenous knowledge informs seasonal forecasting and responses to climatic stress (Moti et al., 2025), while similar practices have been documented elsewhere in East Africa (Dinsa et al., 2022; Guye et al., 2022). In the Ngorongoro Conservation Area, local ecological knowledge is closely connected with pastoral livelihoods and human–wildlife coexistence (Linuma et al., 2022). Its continuity also depends on intergenerational transmission, which may be weakened by changing livelihoods, formal education, and wider social change among Maasai communities in Tanzania (Pesambili, 2025).

Within tourism destinations, TEK can support guiding, storytelling, heritage interpretation, cultural identity, and place-based visitor experiences. Indigenous knowledge and socio-cultural values may contribute to Sustainable Tourism when communities retain authority over how their knowledge and heritage are represented and used (Shrestha et al., 2025). However, tourism may also create risks of commodification, inappropriate representation, and loss of community control. Similarly, ecological knowledge may support wildlife coexistence and resource stewardship while neighbouring communities continue to bear conservation related livelihood costs (Linuma et al., 2022; Raycraft et al., 2024). TEK is therefore best understood as a living community resource whose sustainability relevance is shaped by livelihood, conservation, and institutional conditions.

Despite growing recognition of Indigenous and local knowledge, much of the literature has concentrated on biodiversity conservation, climate adaptation, natural resource management, seasonal forecasting, and cultural heritage (Dinsa et al., 2022; Guye et al., 2022; Sinthumule, 2023). Emerging tourism research recognizes the value of Indigenous knowledge and socio-cultural values (Shrestha et al., 2025), but limited evidence establishes whether TEK is significantly associated with Sustainable Tourism as a multidimensional outcome comprising economic, environmental, and socio-cultural sustainability. This gap is particularly relevant in protected-area communities in northern Tanzania.

Accordingly, this study examined the relationship between Traditional Ecological Knowledge and Sustainable Tourism among communities adjacent to Arusha National Park, Tanzania. Sustainable Tourism was examined



through its economic, environmental, and socio-cultural dimensions, while TEK reflected ecological knowledge and its application, seasonal knowledge, intergenerational transmission, conservation related practices, and cultural heritage. Using a convergent mixed-methods approach, the study combined quantitative evidence on the TEK and Sustainable Tourism relationship with qualitative evidence providing contextual understanding of that relationship. The study addressed the following research question: *What is the relationship between Traditional Ecological Knowledge and Sustainable Tourism among communities adjacent to Arusha National Park, Tanzania?*

The corresponding null hypothesis was:

H₀₁: *Traditional Ecological Knowledge has no statistically significant relationship with Sustainable Tourism among communities adjacent to Arusha National Park, Tanzania.*

Literature Review

Theoretical Review

This study is guided by Social Exchange Theory (SET) and Cultural Ecology as complementary perspectives. Cultural Ecology explains how Traditional Ecological Knowledge (TEK) develops and adapts through interactions among communities, livelihoods, culture, and the environment, while SET explains how perceived tourism and conservation benefits and costs may shape community attitudes and support. Together, they provide a community centered basis for interpreting the relationship between Traditional Ecological Knowledge (TEK) and Sustainable Tourism (ST) in protected area destinations.

Social Exchange Theory

Social Exchange Theory explains social relationships through perceived benefits and costs associated with exchange (Homans, 1958; Blau, 1964). In tourism, it is widely used to explain residents' support for tourism development, with trust, power, perceived benefits, and perceived costs influencing community attitudes (Nunkoo & Ramkissoon, 2012).

SET is relevant to TEK because tourism benefits may extend beyond income and employment to recognition of local ecological knowledge, protection of culturally significant landscapes, cultural continuity, and intergenerational knowledge transmission. Conversely, exclusion from decision-making, restrictions on customary resource use, human-wildlife conflict, or inappropriate commercial use of community knowledge may increase perceived costs and weaken support for tourism and conservation. However, SET cannot fully explain stewardship rooted in cultural identity, attachment to place, customary obligations, spirituality, or responsibility to



future generations. These motivations extend beyond deliberate benefit cost calculations and require a complementary theoretical perspective.

Cultural Ecology

Cultural Ecology, principally associated with Steward (1955), examines how societies interact with and adapt to their environments through culture, livelihoods, technology, behavior, and knowledge. It is particularly relevant to TEK because knowledge of wildlife, plants, water, grazing conditions, seasonal change, resource use practices, and culturally important landscapes develops through repeated community environment interaction.

TEK is therefore not simply inherited information but knowledge that is applied, adapted, and transmitted as ecological and livelihood conditions change. In protected area tourism, such knowledge may inform resource use, wildlife coexistence, seasonal livelihood decisions, environmental stewardship, and cultural practices. Evidence from Maasai communities in Tanzania similarly shows the continuing interconnection among Indigenous knowledge, cultural institutions, land use practices, and ecological stewardship (Bell et al., 2025).

Cultural Ecology also explains why TEK is dynamic rather than static. Communities continually adjust practices in response to environmental change, conservation regulations, education, tourism, livelihood change, and evolving social institutions. TEK may therefore relate to environmental sustainability through stewardship, socio-cultural sustainability through heritage and knowledge transmission, and economic sustainability where local knowledge supports tourism-related livelihoods and experiences.

Complementarity and Limitations of the Theories

SET and Cultural Ecology are used as complementary rather than competing perspectives. Cultural Ecology explains how TEK develops and remains embedded in community and environment relationships, while SET explains how tourism and conservation benefits, costs, participation, and recognition may influence community responses.

Both theories have limitations. SET may overemphasize rational benefit-cost calculations and inadequately capture identity, cultural obligations, spirituality, and intergenerational responsibility. Tourism research also shows that identity and power influence community support beyond simple economic exchange (Nunkoo & Gursoy, 2012; Nunkoo & Ramkissoon, 2012).

Cultural Ecology may, in contrast, overstate the adaptive or environmentally sustainable character of traditional practices. Not all customary practices necessarily produce positive conservation outcomes, particularly under resource scarcity, demographic pressure, livelihood change,



or environmental stress. It may also understate power inequalities between communities and formal conservation institutions.

The study therefore does not assume that TEK automatically produces Sustainable Tourism. Instead, the two theories provide complementary lenses for interpreting how ecological knowledge, cultural practices, community and environment relationships, and perceived tourism benefits and costs may be associated with Sustainable Tourism.

Empirical Literature Review

Traditional Ecological Knowledge and Sustainable Tourism

Traditional Ecological Knowledge (TEK) is increasingly recognized as relevant to Sustainable Tourism because destinations depend on environmental quality, cultural heritage, and community relationships with local resources. TEK may support sustainability through ecosystem knowledge, customary resource management practices, cultural interpretation, and community stewardship. However, these contributions are often examined separately rather than in relation to Sustainable Tourism as a multidimensional outcome.

Recent tourism research illustrates this potential. Shrestha et al. (2025) found that Indigenous knowledge and socio-cultural values supported tourism through community collaboration and culturally grounded practices. Other ecotourism research similarly indicates that local knowledge, traditional norms, community institutions, and conservation practices can support environmental protection and community welfare. Nevertheless, tourism use of Indigenous knowledge raises concerns about ownership, authenticity, representation, and community authority over culturally sensitive knowledge. Overall, existing evidence suggests a positive relationship between TEK and tourism sustainability, but remains predominantly qualitative and context specific. Limited quantitative evidence establishes whether TEK remains significantly associated with Sustainable Tourism when other forms of community participation are considered.

Traditional Ecological Knowledge and Environmental Sustainability

The strongest empirical evidence on TEK concerns environmental sustainability. Local knowledge of species, landscapes, seasonal change, water, grazing conditions, and forests can support biodiversity conservation and sustainable resource use, particularly where practices are embedded in customary institutions.

Sinthumule's (2023) systematic review identified African TEK practices involving customary rules, taboos and totems, traditional protected areas, ecological knowledge, and local resource-management systems. However, the evidence remains geographically uneven, with relatively few studies from



Tanzania. Research in northern Tanzania likewise demonstrates connections among Indigenous knowledge, land and water management, livestock systems, and environmental stewardship.

TEK should nevertheless not be assumed to produce environmental sustainability automatically. Environmental change, livelihood pressures, institutional change, restricted resource access, and limited authority within formal conservation systems can constrain its application. Its environmental contribution is therefore context dependent, particularly because perceived TEK cannot itself demonstrate objectively measured ecological improvement.

Traditional Ecological Knowledge and Socio-Cultural Sustainability

TEK contributes to socio-cultural sustainability through its transmission in language, oral traditions, customary institutions, livelihood practices, beliefs, and relationships with culturally significant landscapes. Its continuity can therefore reinforce cultural identity, heritage, and attachment to place.

Intergenerational transmission is particularly important. Evidence from Maasai communities in Tanzania indicates that elders and cultural institutions continue to transmit ecological knowledge and values, although formal education, livelihood change, and wider social transformation may weaken these processes (Pesambili, 2025). Tourism may provide opportunities to sustain and share such knowledge, and Indigenous knowledge and socio-cultural values can support culturally grounded tourism development (Shrestha et al., 2025). However, tourism may also commodify or simplify cultural knowledge. Socio-cultural sustainability therefore depends on maintaining community ownership, appropriate representation, and authority over what knowledge is shared and how it is used.

Traditional Ecological Knowledge and Economic Sustainability

TEK's relationship with economic sustainability is less direct. Although primarily a knowledge and cultural resource, it may support tourism livelihoods through guiding, cultural interpretation, handicrafts, traditional practices, community based tourism, and nature-based visitor experiences. In Tanzania, community-based cultural tourism demonstrates how local cultural and environmental knowledge can contribute to visitor experiences and tourism livelihoods, although benefits depend on wider institutional and market conditions (Mgonja et al., 2021). TEK alone therefore does not establish economic sustainability: income and employment also depend on market access, ownership, skills, infrastructure, visitor demand, and benefit distribution. Accordingly, TEK may support tourism livelihood opportunities, but should not be interpreted as direct evidence of increased income,



employment, or household welfare unless these outcomes are independently demonstrated.

Traditional Ecological Knowledge in Protected Area Governance

TEK is particularly relevant to protected areas because conservation landscapes are simultaneously ecological, livelihood, and cultural spaces. Neighbouring communities may possess detailed knowledge of wildlife, vegetation, water, grazing areas, seasonal change, and culturally important places. Research indicates that integrating Indigenous knowledge into conservation and tourism can support environmental stewardship, cultural continuity, and local economies when community rights and decision-making authority are recognized (Nyaupane et al., 2022). However, formal conservation systems may privilege institutional or scientific knowledge, while restrictions on land and resource access can constrain the practice and transmission of TEK.

Protected area tourism therefore presents both opportunities and constraints. Its contribution depends not simply on possessing local ecological knowledge but on participation, institutional recognition, power relations, and community authority over knowledge and resources.

Evidence from East Africa and Tanzania

East Africa provides an important context because tourism, pastoral livelihoods, wildlife conservation, and protected areas frequently share interconnected landscapes. Indigenous communities have developed knowledge of rainfall, drought, grazing conditions, wildlife behavior, vegetation, water availability, and seasonal environmental change.

In northern Tanzania, Bell et al. (2025) describe Maasai ecological knowledge as embedded in pastoral livelihoods, land and water management, cultural institutions, and community stewardship. Similarly, Moti et al. (2025) found that Maasai agro-pastoralists use Indigenous seasonal forecasting and traditional calendars in livelihood decision-making. Comparable practices have been documented elsewhere in East Africa (Dinsa et al., 2022; Guye et al., 2022).

These studies establish the continuing relevance of Indigenous ecological knowledge but largely focus on conservation, pastoral livelihoods, climate adaptation, and resource management. Evidence remains limited on whether TEK is statistically associated with multidimensional Sustainable Tourism, particularly when economic, environmental, and socio-cultural sustainability are considered together in communities adjacent to protected areas in northern Tanzania.



Research Gap and Empirical Hypothesis Development

Although Traditional Ecological Knowledge (TEK) is increasingly recognized in biodiversity conservation, natural resource management, climate adaptation, cultural heritage, and community livelihoods (Sinthumule, 2023), its relationship with Sustainable Tourism as a multidimensional outcome remains less clearly established.

A conceptual gap arises because TEK is frequently examined within broader Indigenous knowledge, conservation, or community-participation frameworks rather than as a distinct construct related to Sustainable Tourism. Yet its relationship may differ across sustainability dimensions: ecological knowledge and stewardship may support environmental sustainability, cultural continuity and knowledge transmission may support socio-cultural sustainability, while tourism applications of local knowledge may contribute to livelihood opportunities.

An empirical and methodological gap also remains. Existing studies demonstrate the relevance of TEK to conservation, cultural heritage, seasonal adaptation, and resource management, but fewer quantitatively test its association with multidimensional Sustainable Tourism. Much of the literature is qualitative and context-specific, providing rich explanations of community knowledge and practices but limited evidence on the magnitude of the TEK and Sustainable Tourism relationship. A convergent mixed methods approach can therefore combine statistical assessment with contextual understanding. A contextual gap is particularly evident in East African protected area tourism.

Studies from Tanzania and the wider region demonstrate the continuing importance of Indigenous knowledge to pastoral livelihoods, seasonal forecasting, environmental stewardship, and cultural continuity (Bell et al., 2025; Dinsa et al., 2022; Guye et al., 2022; Moti et al., 2025; Pesambili, 2025). However, limited evidence establishes whether TEK is significantly associated with multidimensional Sustainable Tourism among communities neighbouring protected areas in northern Tanzania.

The present study addresses these gaps by examining TEK as a distinct dimension of Local Community Participation and its relationship with Sustainable Tourism among communities adjacent to Arusha National Park. Sustainable Tourism is examined through its economic, environmental, and socio-cultural dimensions. Tourism Planning and Tourism Entrepreneurship are included as the other Local Community Participation dimensions, while Government Support is treated as an institutional variable, enabling assessment of whether TEK retains a significant relationship with Sustainable Tourism after accounting for these related constructs.

Social Exchange Theory and Cultural Ecology provide complementary grounds for expecting a positive relationship. Cultural Ecology explains how ecological knowledge develops and adapts through community and



environment interactions, while Social Exchange Theory explains how perceived tourism and conservation benefits and costs may influence community attitudes and support. Together, the theoretical and empirical literature provides a basis for expecting a positive TEK and Sustainable Tourism relationship without assuming causality or uniformly beneficial outcomes.

Research Methodology

Research Philosophy

The study was guided by pragmatism, which prioritizes the research problem and the methods best suited to addressing it rather than adherence to a single philosophical tradition. Pragmatism supports integrating quantitative and qualitative evidence where their combination provides a more comprehensive understanding of a research problem (Creswell & Creswell, 2018; Creswell & Plano Clark, 2018).

This orientation was appropriate because examining the relationship between Traditional Ecological Knowledge (TEK) and Sustainable Tourism required statistical evidence alongside contextual understanding of how ecological knowledge is practiced, transmitted, and experienced in communities adjacent to Arusha National Park. Pragmatism therefore supported a convergent mixed methods design in which quantitative and qualitative data were collected concurrently, analyzed separately, and integrated during interpretation, with documentary evidence providing supplementary institutional and policy context (Creswell & Plano Clark, 2018).

Research Design

The study employed a convergent mixed-methods design, with quantitative and qualitative data collected during the same research phase, analyzed separately, and integrated during interpretation (Creswell & Plano Clark, 2018). The design enabled the statistical relationship between TEK and Sustainable Tourism to be examined alongside community and institutional experiences concerning ecological knowledge, conservation practices, seasonal knowledge, intergenerational transmission, and cultural heritage.

The quantitative strand comprised a cross sectional community survey. TEK was the focal predictor, while Tourism Planning (TP) and Tourism Entrepreneurship (TE), the other dimensions of Local Community Participation, and Government Support (GS) were retained as theoretically relevant variables in the multivariable analysis. The qualitative strand comprised semi-structured interviews with purposively selected stakeholders from local government, tourism related organizations and enterprises, community leadership, and non-governmental organizations.



A convergent rather than sequential design was appropriate because neither strand was developed in response to findings from the other. Following separate analyses, findings were integrated through side by side comparison and weaving to identify convergence, complementarity, qualification, and divergence.

Study Area

The study was conducted in Meru District Council (MDC), Arusha Region, northern Tanzania (Figure 1), focusing on King'ori, Maruvango, and Leguruki wards adjacent to Arusha National Park (ANAPA). Their proximity to the protected area creates interactions among tourism, conservation, natural resource use, and community livelihoods relevant to examining TEK and Sustainable Tourism.

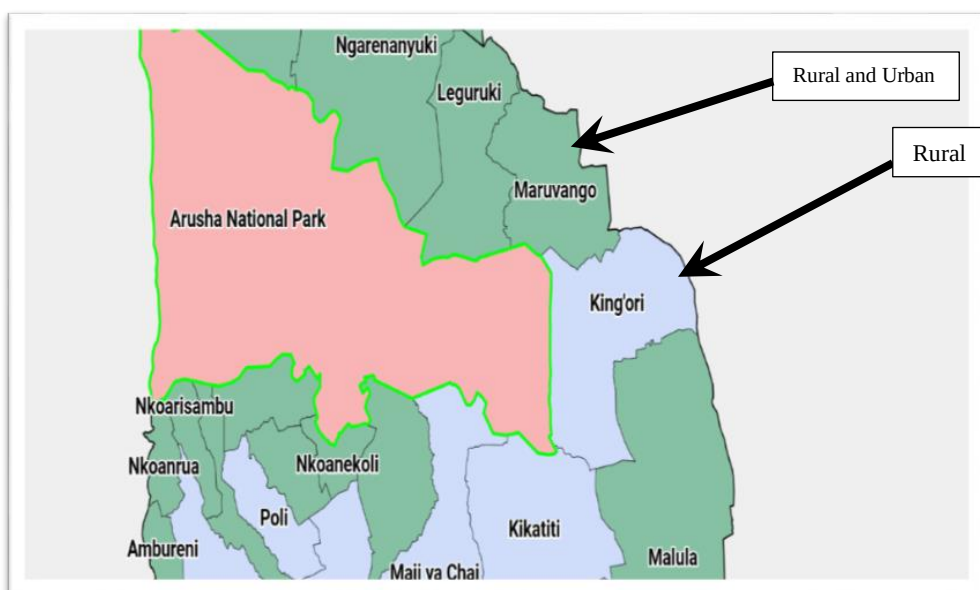


Figure 1. Location of Selected Wards Adjacent to Arusha National Park

Source: National Bureau of Statistics, Tanzania (2022).

MDC covers approximately 1,266 km² and had a population of approximately 331,360 in 2022. The three study wards had a combined population of 32,358: King'ori (13,034), Maruvango (9,796), and Leguruki (9,528) (National Bureau of Statistics [NBS], 2022). The district forms part of Tanzania's Northern Tourism Circuit, with livelihoods including agriculture, livestock keeping, tourism and hospitality, and small scale enterprise.

The coexistence of tourism, conservation, community livelihoods, natural resource use, and conservation related pressures, including human wildlife interactions and restrictions on some resource uses, makes the area

appropriate for examining TEK in relation to the economic, environmental, and socio-cultural dimensions of Sustainable Tourism.

Table 1. Characteristics of the Study Wards

Ward	Area (km ²)	Population	Population density/km ²	Status
King'ori	53.11	13,034	245.4	Urban and rural
Maruvango	35.41	9,796	276.6	Rural
Leguruki	38.84	9,528	245.3	Rural

Source: National Bureau of Statistics [NBS], Tanzania (2022).

Target Population and Sampling

The quantitative target population comprised adult residents of wards adjacent to Arusha National Park (ANAPA). Community residents were appropriate respondents because the study conceptualized Traditional Ecological Knowledge (TEK) as locally held ecological knowledge and practices concerning ecosystems, natural resource use, seasonal change, human-wildlife interactions, cultural heritage, and intergenerational knowledge transmission. The qualitative population comprised stakeholders with relevant experience in tourism, conservation, community participation, cultural heritage, and related institutional processes within Meru District Council.

The broader study initially considered six wards adjacent to ANAPA: Maji ya Chai, Kikatiti, King'ori, Maruvango, Leguruki, and Ngarenanyuki. Security related access constraints during the 2025 post-election period prevented safe fieldwork in some locations. Data collection was therefore conducted in the accessible wards of King'ori, Maruvango, and Leguruki, with a combined population of 32,358 (National Bureau of Statistics [NBS], 2022).

Sample Size Determination

The quantitative sample size was determined using Cochran's (1977) formula:

$$n = Z^2 \cdot p(1-p) / e^2$$

Where:

n = sample size

Z = 1.96 (confidence level = 95%)

P=0.5

e=0.05

Substituting the values:

$$n = [(1.96 \times 1.96) \times 0.5(1-0.5)] / 0.0025 = 384.16 \approx 384$$

The planned sample of 384 respondents was allocated proportionately according to ward population as shown in Table 2.



Table 2. Population and Planned Quantitative Sample by Ward

Ward	Population	Planned sample
King'ori	13,034	155
Maruvango	9,796	116
Leguruki	9,528	113
Total	32,358	384

Source: NBS Tanzania (2022); Data Analysis (2025).

Sampling Procedures

For the quantitative strand, each ward constituted a geographical stratum, with eligible participants restricted to residents aged 18 years or above. NBS (2022) population figures were used for proportional allocation. Because a complete individual level sampling frame of eligible adults was unavailable, probability selection of individuals within strata was not possible. Trained research assistants therefore recruited eligible residents within each ward toward the predetermined allocation.

Table 3. Planned Qualitative Sample by Stakeholder Category

Key-informant category	Planned sample
Tourism officers	2
Local government officers	3
NGO representatives	8
Community leaders	2
Hoteliers	2
Tour guides	2
Craft vendors	6
Total	25

Source: Data Analysis (2025).

Ward Executive Officers facilitated community entry but neither selected participants nor influenced responses.

For the qualitative strand, purposive sampling was planned to recruit key informants based on their roles, experience, and involvement in tourism, conservation, community participation, cultural heritage, and related institutional processes. A total of 25 key informants was planned across seven stakeholder categories to capture community, tourism-enterprise, conservation, and institutional perspectives relevant to the study as presented in Table 3.

Data Collection Methods

Data were collected using structured questionnaires and semi-structured key-informant interviews, supplemented by documentary review.



Quantitative Data Collection

Quantitative data were collected from adult community residents using a structured questionnaire measuring Tourism Planning, Tourism Entrepreneurship, Traditional Ecological Knowledge (TEK), Government Support, and the economic, environmental, and socio-cultural dimensions of Sustainable Tourism. Items were rated on a five-point Likert scale from 1 = Strongly Disagree to 5 = Strongly Agree, alongside socio-demographic questions.

TEK was measured using 10 perception based items addressing community ecological knowledge, sustainable natural resource management, livelihood application of traditional knowledge, elders as knowledge holders, human-wildlife conflict management, seasonal knowledge, intergenerational transmission, tourism-related knowledge sharing, cultural-heritage protection, and perceived contribution to Sustainable Tourism.

Questionnaires were self-completed with support from three trained research assistants; one assigned to each ward. Ward Executive Officers facilitated community access but were not involved in questionnaire completion or participant responses.

Qualitative Data Collection

Semi-structured key informant interviews were conducted personally by the researcher using an interview guide that allowed probing and clarification. The guide addressed the broader study constructs, including community participation, Traditional Ecological Knowledge, conservation, cultural heritage, tourism benefits, Government Support, and Sustainable Tourism.

In this study, analysis focused on interview material relevant to TEK and Sustainable Tourism, including indigenous conservation practices, ecological and seasonal knowledge, intergenerational knowledge transmission, cultural heritage, human wildlife interactions, and community experiences of tourism and conservation.

Documentary Review

Documentary review provided supplementary institutional and policy context. Relevant tourism and conservation policies, institutional reports, strategic frameworks, guidelines, and government and conservation-related publications were selected for their relevance to TEK, community participation, cultural heritage, conservation, institutional support, and Sustainable Tourism. Relevant material was organized thematically and considered alongside survey and interview evidence during mixed methods integration.



Measurement of Variables

Study variables were operationalized using literature informed multi item measures aligned with the conceptual framework and study objectives. Items were rated on a five point Likert scale from 1 = Strongly Disagree to 5 = Strongly Agree, and corresponding items were aggregated into composite scores for analysis (DeVellis, 2017).

Traditional Ecological Knowledge

Traditional Ecological Knowledge (TEK), the focal predictor, was measured using 10 perception-based items covering knowledge of local ecosystems; traditional natural resource management; application of TEK in livelihoods; elders as knowledge holders; human wildlife conflict management; seasonal and weather knowledge; intergenerational transmission; tourism related knowledge sharing; cultural heritage protection; and the perceived relevance of TEK to Sustainable Tourism.

TEK was measured at the individual respondent level and therefore represents perceptions of community ecological knowledge and its application, rather than objectively observed ecological practices or an assessment of the total knowledge held by the community.

Other Explanatory Variables

Tourism Planning (TP) and Tourism Entrepreneurship (TE), the other dimensions of Local Community Participation, were each measured using 10 perception based items. TP covered community involvement and influence in tourism planning, transparency, stakeholder communication, sustainability orientation, and cultural considerations. TE covered tourism-business opportunities, entrepreneurial capacity, access to finance and markets, regulatory support, training, local enterprise benefits, and participation opportunities.

Government Support (GS) was measured using 10 items addressing policies and programmes, infrastructure, regulatory and financial support, institutional partnerships, marketing, capacity development, community participation, innovation, and support for Sustainable Tourism. TP, TE, and GS were retained as theoretically specified variables in the multivariable analysis.

Sustainable Tourism

Sustainable Tourism (ST) comprised three dimensions, each measured using 10 perception-based items. Economic Sustainability covered employment, income, local enterprise benefits, benefit distribution, and livelihoods; Environmental Sustainability covered natural resource conservation, environmentally responsible tourism, awareness, waste management, and sustainable resource use; and Socio-Cultural Sustainability



covered cultural preservation, cultural pride, social relationships, respect for local customs, cultural tourism, and transmission of cultural values.

Dimension level composites were combined to generate the overall ST score used in inferential analysis. ST is therefore interpreted as a multidimensional composite rather than an empirically established higher-order latent construct, because a higher-order measurement model was not estimated. The measures represent perceived rather than independently observed sustainability outcomes.

Instrument Development

The scales were researcher developed and literature informed rather than adopted from a single validated instrument. TEK items were informed by literature on Indigenous ecological knowledge, community conservation, sustainability practices, and community resources (Ianni et al., 2015; Mmbaga et al., 2024; Smith, 2009).

The initial item pool was reviewed by two thesis supervisors and two tourism officers from Meru District Council for relevance, clarity, construct coverage, and contextual appropriateness and subsequently refined following pilot testing in Arusha City. Illustrative TEK and Sustainable Tourism items are presented in Table 4.

Table 4. Questionnaire Items for Traditional Ecological Knowledge and Sustainable Tourism

Construct/Dimension	Code	Questionnaire item
Traditional Ecological Knowledge	TEK1	Community members possess deep knowledge of local plants, animals, and ecosystems.
	TEK4	Elders are important sources of traditional environmental knowledge.
	TEK6	Local weather or seasonal changes can be predicted using traditional knowledge.
Economic Sustainability	ECs1	Tourism contributes positively to household income in this community.
	ECs2	Tourism has increased employment opportunities for residents.
	ECs5	Tourism revenues are fairly shared among community members.



Environmental Sustainability	ENVs1	Tourism encourages the conservation of natural resources.
	ENVs4	Tourism supports the protection of forests, rivers, and water sources.
	ENVs9	Tourism helps reduce illegal resource use, such as poaching and logging.
Socio-Cultural Sustainability	SCs1	Tourism promotes the preservation of local culture and traditions.
	SCs3	Tourism strengthens social relationships within the community.
	SCs9	Tourism promotes positive interactions between residents and tourists.

Note. Items were rated from 1 = Strongly Disagree to 5 = Strongly Agree. TEK comprised 10 items; each Sustainable Tourism dimension comprised 10 items.

Source: Data Analysis (2025).

Composite Measures

Following data screening, item responses were aggregated to generate composite scores for TEK, TP, TE, and GS. Economic, environmental, and socio-cultural sustainability composites were similarly generated and combined to produce the overall Sustainable Tourism score used in the inferential analysis.

Validity and Reliability

Validity of the Instruments

Content and face validity were assessed through literature-informed instrument development, expert review, and pilot testing. Two thesis supervisors and two tourism officers from Meru District Council reviewed the initial items for relevance, clarity, construct coverage, and contextual appropriateness. Based on this process, the initial 15 items for Tourism Planning, Tourism Entrepreneurship, Traditional Ecological Knowledge (TEK), and Government Support were refined to 10 items per construct. Sustainable Tourism comprised three 10-item dimensions: economic, environmental, and socio-cultural sustainability.

Theoretical alignment, operational definitions, and expert review were used to support construct representation. However, exploratory and confirmatory factor analyses were not conducted; therefore, factor-analytic



construct validity was not established. The refined questionnaire was pilot tested with 40 respondents in Arusha City, outside the study wards, to assess clarity, comprehensibility, consistency, and contextual appropriateness. Identified ambiguities were addressed before the main survey. For the qualitative strand, trustworthiness was supported through a semi-structured interview guide, systematic comparison of themes across interviews, preservation of contextual accounts, and triangulation with documentary evidence.

Reliability of the Instrument

Internal consistency was assessed using Cronbach's alpha (α) from the 40 pilot respondents, with coefficients of approximately .70 or above considered acceptable (Hair et al., 2010; Taber, 2018). As shown in Table 5, coefficients ranged from $\alpha = .70$ to .88. The focal TEK scale recorded $\alpha = .78$, while Economic, Environmental, and Socio-Cultural Sustainability recorded $\alpha = .85$, .88, and .83, respectively. The overall Sustainable Tourism measure recorded $\alpha = .85$, supporting acceptable internal consistency of the measures used in the main survey.

Table 5. Pilot-Study Reliability Analysis

Construct	Number of items	Cronbach's α	Interpretation
Tourism Planning	10	.72	Acceptable
Tourism Entrepreneurship	10	.83	Good
Traditional Ecological Knowledge	10	.78	Acceptable
Government Support	10	.70	Acceptable
Economic Sustainability	10	.85	Good
Environmental Sustainability	10	.88	Good
Socio-cultural Sustainability	10	.83	Good
Sustainable Tourism — Overall	30	.85	Good

Source: Data Analysis (2025).

Data Analysis

Quantitative and qualitative data were analyzed separately and subsequently integrated in accordance with the convergent mixed methods design. Quantitative analysis comprised data screening, descriptive statistics, Pearson correlation, and hierarchical multiple linear regression using



Microsoft Excel and IBM SPSS Statistics. Interview data were analyzed primarily through thematic analysis, supported by content and narrative interpretation, while documentary evidence provided supplementary institutional and policy context.

Quantitative Data Screening and Preparation

Questionnaire data were screened for missing values, outliers, and inconsistencies. For retained cases with less than 5% missing responses, missing values were handled using hot-deck imputation based on observed responses from similar cases (Baraldi & Enders, 2010). Item responses were subsequently aggregated into composite measures for Traditional Ecological Knowledge (TEK), Tourism Planning (TP), Tourism Entrepreneurship (TE), Government Support (GS), and Sustainable Tourism (ST).

Descriptive and Correlation Analysis

Frequencies and percentages summarized respondent characteristics, while means and standard deviations described the study constructs and the three Sustainable Tourism dimensions. Pearson's product-moment correlation (r) examined bivariate associations among the composite measures, with Traditional Ecological Knowledge TEK and Sustainable Tourism as the focal relationship.

Hierarchical Multiple Linear Regression

Hierarchical multiple linear regression examined the association between TEK and ST while accounting for other theoretically specified variables. Predictors were entered according to the original analytical structure:

Model 1 included the three dimensions of Local Community Participation:

$$ST = \beta_0 + \beta_1TP + \beta_2TE + \beta_3TEK + \varepsilon$$

Model 2 added Government Support:

$$ST = \beta_0 + \beta_1TP + \beta_2TE + \beta_3TEK + \beta_4GS + \varepsilon$$

Model 3 retained the interaction specified in the present study between overall Local Community Participation and Government Support:

$$ST = \beta_0 + \beta_1TP + \beta_2TE + \beta_3TEK + \beta_4GS + \beta_5(GS \times LCP) + \varepsilon$$

Where ST = Sustainable Tourism, TP = Tourism Planning, TE = Tourism Entrepreneurship, TEK = Traditional Ecological Knowledge, GS = Government Support, and LCP = Local Community Participation. Model comparisons considered R^2 , adjusted R^2 , ΔR^2 , overall model significance, and regression coefficients.



Traditional Ecological Knowledge (TEK) was the focal predictor for this article. TP and TE represented the other Local Community Participation dimensions, while GS was added as an institutional predictor. The Model 3 interaction represents the broader LCP $\times$ GS specification and is not interpreted as a TEK specific moderation effect.

Regression Diagnostics

Regression assumptions were assessed using residual plots for linearity and homoscedasticity, histograms and Probability-Probability (P-P) plots for residual normality, tolerance and Variance Inflation Factor (VIF) statistics for multicollinearity, and the Durbin-Watson statistic for independence of errors. Standardized residuals, Cook's Distance, leverage, and Mahalanobis Distance were used to assess potentially influential observations.

Qualitative Data Analysis

Interview data were analyzed primarily using thematic analysis (Braun & Clarke, 2006, 2021). Relevant material was coded and conceptually related codes organized into categories and themes. For this article, analysis focused on interview evidence relevant to TEK and Sustainable Tourism, including ecological knowledge, conservation practices, seasonal knowledge, intergenerational transmission, cultural heritage, human wildlife interactions, and protected-area experiences.

Content analysis supported comparison of recurring issues across participants, while narrative interpretation retained contextual accounts. Documentary evidence was reviewed thematically to provide supplementary institutional and policy context (Bowen, 2009).

Quantitative, qualitative and documentary findings were integrated during interpretation through side-by-side comparison and weaving to identify convergence, complementarity, qualification, and divergence. This enabled the statistical Traditional Ecological Knowledge (TEK) and Sustainable Tourism (ST) relationship to be interpreted alongside contextual evidence concerning ecological knowledge, conservation, knowledge transmission, cultural heritage, and protected-area experiences.

Ethical Considerations

The study complied with ethical requirements for research involving human participants. Research authorization was obtained from Moi University (Ref: MU/STHE/PG/23, dated 19th August, 2025), together with administrative permission from the appropriate regional, district, and ward authorities. Research authorization was obtained from the Tanzania Wildlife Research Institute (TAWIRI) (Ref. No. AB.235/325/01"A"/125, dated 11th December



2025). and Tanzania Commission for Science and Technology (COSTECH) (Permit No. CST00001592- 2025-2025-01409, dated 15 December 2025).

Participation was voluntary, and informed consent was obtained from survey respondents and key informants. Participants were informed of the study purpose, use of the information collected, their right to decline questions, and their right to withdraw without penalty. Local authorities facilitated community access but did not replace individual consent.

Confidentiality and privacy were maintained throughout the study. Quantitative findings were reported in aggregate; qualitative participants were identified by codes rather than names, and research data were securely stored and restricted for academic use.

Results

Response Rate and Sample Characteristics

Of the 384 questionnaires planned for the quantitative strand, 352 usable responses were obtained, giving an overall response rate of 91.7%. The achieved sample comprised 148 respondents from King'ori, 101 from Maruvango, and 103 from Leguruki. Ward-level response rates ranged from 87.1% in Maruvango to 95.5% in King'ori as shown in Table 6.

Table 6. Survey Response and Achieved Sample by Ward

Ward	Planned sample	Usable responses	Response rate (%)
King'ori	155	148	95.5
Maruvango	116	101	87.1
Leguruki	113	103	91.2
Total	384	352	91.7

Source: Data Analysis (2025).

For the qualitative strand, 15 of the 25 planned key informants participated in the interviews. Participants were purposively recruited through relevant offices, institutions, community leadership structures, and tourism related businesses within Meru District Council based on their occupational or institutional relevance. The achieved sample represented tourism and local government offices, NGOs, community leadership, and tourism enterprises. All 15 participants were men. Age and ward of residence were not qualitative selection criteria and were not systematically recorded.

Selected characteristics of the 352 survey respondents are presented in Table 7. Men constituted 72% and women 28%, with respondents varying in age, education, occupation, household size, and length of residence. Tourism related employment was the main occupation of 43%, while 74%



reported that they or another household member received tourism derived income. The sample therefore represented community residents with varying levels of direct and household exposure to tourism related livelihoods rather than exclusively tourism entrepreneurs or employees.

Descriptive Statistics of the Study Constructs

Descriptive statistics are presented in Table 8. On the five-point scale, mean scores of 1.00-1.80 were interpreted as very low, 1.81-2.60 as low, 2.61-3.40 as moderate, 3.41- 4.20 as high, and 4.21-5.00 as very high.

Traditional Ecological Knowledge (TEK) recorded a very high mean ($M = 4.48$, $SD = 0.40$), with scores ranging from 3.10 to 5.00. This indicates generally strong respondent perceptions of ecological knowledge, conservation practices, seasonal knowledge, intergenerational transmission, and cultural heritage. As a perception-based composite, the score should not be interpreted as an objective measure of ecological knowledge or conservation performance.

Overall Sustainable Tourism was moderate ($M = 3.34$, $SD = 0.30$). Socio-Cultural Sustainability recorded the highest mean ($M = 3.44$, $SD = 0.32$), followed by Economic Sustainability ($M = 3.31$, $SD = 0.29$) and Environmental Sustainability ($M = 3.27$, $SD = 0.31$). These values are descriptive; no inferential comparison among the three dimensions was conducted. Among the other study constructs, Tourism Entrepreneurship recorded a high mean ($M = 3.97$, $SD = 0.31$), Government Support was moderate ($M = 3.31$, $SD = 0.45$), and Tourism Planning was low ($M = 2.50$, $SD = 0.37$).

Table 8. Descriptive Statistics of the Study Constructs

Construct	N	Minimum	Maximum	Mean	SD	Interpretation
Traditional Ecological Knowledge	352	3.10	5.00	4.48	0.40	Very high
Sustainable Tourism	352	2.27	3.97	3.34	0.30	Moderate
Economic Sustainability	352	2.39	4.03	3.31	0.29	Moderate
Environmental Sustainability	352	2.17	3.36	3.27	0.31	Moderate
Socio-Cultural Sustainability	352	2.25	4.52	3.44	0.32	High
Tourism Entrepreneurship	352	1.60	3.60	2.50	0.37	Low
Government Support	352	1.60	3.60	2.50	0.37	Low
Tourism Planning	352	1.60	3.60	2.50	0.37	Low



Tourism Entrepreneurship	35	2.60	4.70	3.97	0.31	High
Government Support	35	2.50	4.90	3.31	0.45	Moderate

Source: Data Analysis (2025).

Pearson Correlation Analysis

Pearson's product-moment correlation examined bivariate associations among Tourism Planning (TP), Tourism Entrepreneurship (TE), Traditional Ecological Knowledge (TEK), Government Support (GS), and Sustainable Tourism (ST).

As shown in Table 9, TEK was positively associated with Sustainable Tourism ($r = .607$, $p < .001$), indicating that higher perceived TEK was associated with higher perceived Sustainable Tourism. The relationship represents approximately 36.8% bivariate shared variance ($r^2 = .368$) but does not indicate causality or TEK's unique contribution after accounting for other predictors.

Government Support ($r = .626$) and Tourism Entrepreneurship ($r = .625$) were also positively associated with Sustainable Tourism, whereas Tourism Planning showed a weaker negative association ($r = -.196$). Correlations among the predictors ranged from $-.232$ to $.491$. Multicollinearity was subsequently assessed using tolerance and Variance Inflation Factor (VIF) statistics.

Table 9. Pearson Product-Moment Correlation Matrix

Variable	TP	TE	TEK	GS	ST
Tourism Planning (TP)	1.000	-.102	-.232	-.121	-.196
Tourism Entrepreneurship (TE)	-.102	1.000	.423	.424	.625
Traditional Ecological Knowledge (TEK)	-.232	.423	1.000	.491	.607***
Government Support (GS)	-.121	.424	.491	1.000	.626
Sustainable Tourism (ST)	-.196	.625	.607***	.626	1.000

Note. $N = 352$. Pearson product-moment correlations. *** $p < .001$ for the Traditional Ecological Knowledge and Sustainable Tourism relationship.

Source: Data Analysis (2025).

Hierarchical Regression Analysis

Hierarchical multiple linear regression examined the relationship between Traditional Ecological Knowledge (TEK) and Sustainable Tourism (ST) while accounting for other theoretically specified variables. Model 1 included Tourism Planning (TP), Tourism Entrepreneurship (TE), and TEK; Model 2



added Government Support (GS); and Model 3 added the interaction between overall Local Community Participation and Government Support ($LCP \times GS$). The models explained 53.7%, 61.2%, and 61.4% of the variance in Sustainable Tourism, respectively.

Regression diagnostics indicated that the assumptions were adequately satisfied. Durbin-Watson statistics ranged from 1.634 to 1.708, supporting independence of errors, while tolerance and VIF diagnostics indicated no problematic multicollinearity.

Traditional Ecological Knowledge (TEK) remained positively and statistically significantly associated with Sustainable Tourism across all three models. In Model 1, TEK recorded $\beta = .336$, $t = 9.825$, $p < .001$. The association remained significant after Government Support was introduced in Model 2 ($\beta = .233$, $t = 6.909$, $p < .001$) and in the fully specified Model 3 ($\beta = .208$, $t = 5.330$, $p < .001$).

Although the standardized coefficient declined from $\beta = .336$ to $\beta = .208$ as additional variables were introduced, TEK retained a significant adjusted association with Sustainable Tourism. Thus, the Traditional Ecological Knowledge and Sustainable Tourism relationship persisted after accounting for Tourism Planning, Tourism Entrepreneurship, Government Support, and the $LCP \times GS$ interaction. Given the cross-sectional and perception-based design, these coefficients indicate adjusted statistical associations rather than causal effects.

Accordingly, the null hypothesis that Traditional Ecological Knowledge has no statistically significant relationship with Sustainable Tourism among communities adjacent to Arusha National Park was rejected.

Table 10. Hierarchical Regression Models Predicting Sustainable Tourism

Predictor / Model statistic	Model 1	Model 2	Model 3
Tourism Planning (β)	-.046	-.044	-.083
Tourism Entrepreneurship (β)	.433	.349	.328
Traditional Ecological Knowledge (β)	.336***	.233***	.208***
Government Support (β)	-	.219	.227
$LCP \times GS$ (β)	-	-	.132
R^2	.537	.612	.614
Adjusted R^2	.533	.608	.608
ΔR^2	-	.075	.002
F	134.372	136.912	109.987

Note. $N = 352$. Dependent variable = Sustainable Tourism. β = standardized regression coefficient; LCP = Local Community Participation; GS = Government Support. *** $p < .001$. The $LCP \times GS$ interaction was not statistically significant ($p = .222$), and Tourism Planning was not statistically significant across the models. Source: Data Analysis (2025).



Qualitative Findings on Traditional Ecological Knowledge

The qualitative findings provided contextual understanding of how Traditional Ecological Knowledge (TEK) was experienced and applied within communities adjacent to Arusha National Park. Four related themes emerged: environmental stewardship and conservation practices; intergenerational knowledge, cultural heritage and community identity; wildlife coexistence and protected-area livelihood tensions; and stakeholder collaboration in integrating TEK into Sustainable Tourism. The evidence included both supportive and constraining experiences, complementing rather than merely confirming the quantitative findings.

Traditional Ecological Knowledge, Environmental Stewardship and Conservation Practices

Environmental stewardship emerged as a prominent expression of TEK. Participants associated local ecological knowledge with protecting land, forests, wildlife, and other natural resources supporting community livelihoods and nature-based tourism. One participant explained: "*Traditional knowledge helps us protect our land.*" (NR1) Another emphasized community participation: "*Communities help in protecting forests and wildlife.*" (NR1). These accounts indicate that conservation was understood not solely as the responsibility of formal protected-area institutions but also as a community practice informed by locally held knowledge. However, conservation outcomes were not uniformly positive, as one participant observed that "*Some areas still face environmental degradation*" (NR2). TEK therefore operated within wider environmental pressures that community stewardship alone could not eliminate.

Content analysis similarly identified indigenous conservation practices, environmental knowledge, wildlife coexistence, and traditional resource management as prominent issues. The findings therefore connect TEK with environmental sustainability through locally grounded knowledge and stewardship practices relevant to maintaining natural resources on which protected-area tourism depends.

Intergenerational Knowledge, Cultural Heritage and Community Identity

TEK was also closely associated with intergenerational learning, cultural continuity, and community identity. Participants described ecological knowledge as inherited through families and communities and connected with long-standing environmental norms and practices. One participant stated: "*My family has lived here for generations; our culture is tied to this place.*" (TE4) Another linked place attachment with stewardship: "Because I was born here, I feel responsible to protect this area." (NR1)



Tourism was also associated with cultural preservation. One participant observed that *"Tourism has helped us preserve our traditions"* (TO2), while another narrative expressed the perceived interdependence between culture and tourism: *"Tourists come because of our culture. If culture dies, tourism dies."* (NR2, TE6 and CL2). These accounts connect TEK with socio-cultural sustainability through cultural continuity, place attachment, stewardship values, and preservation of the cultural distinctiveness associated with the destination.

Traditional Ecological Knowledge, Wildlife Coexistence and Protected Area Livelihood Tensions

Traditional Ecological Knowledge (TEK) operated within a complex protected-area environment rather than under uniformly favorable conditions. Participants associated inherited ecological knowledge with wildlife coexistence and environmental stewardship while also describing restrictions on natural-resource access and crop damage caused by wildlife.

Despite these costs, participants emphasized protecting wildlife and natural resources for future generations and sustaining tourism. The evidence therefore qualifies any assumption that TEK automatically produces positive sustainability outcomes. Communities may possess substantial ecological knowledge and support conservation while simultaneously bearing livelihood costs associated with protected-area management.

TEK consequently provides knowledge and cultural resources relevant to stewardship and coexistence, but its relationship with Sustainable Tourism is shaped by wider livelihood and protected-area conditions.

Stakeholder Collaboration and Integration of TEK into Sustainable Tourism

Participants also described collaboration among communities, NGOs, conservation institutions, tourism operators, and local leadership through training, joint activities, capacity building, and benefit-sharing. One participant stated that *"Communities and operators work together"* (GO2), while another explained that *"Training helps us conserve wildlife"* (TO2). The connection between benefits and conservation participation was reflected in the observation that *"Shared benefits encourage conservation"* (NR2). Collaboration was nevertheless uneven: *"Some stakeholders do not cooperate well."* (NR3). These findings indicate that the practical relevance of TEK to Sustainable Tourism depends partly on institutional conditions. Community ecological knowledge may support conservation and tourism, but its application can be strengthened or constrained by institutional recognition, capacity building, benefit sharing, and stakeholder coordination.



Synthesis of the Qualitative Findings

Overall, the qualitative findings connected TEK with environmental stewardship, cultural continuity, wildlife coexistence, and stakeholder collaboration. They also revealed constraints involving livelihood costs, resource-access restrictions, environmental pressures, and uneven institutional cooperation. TEK therefore emerged as an important community resource whose relationship with Sustainable Tourism is context-dependent rather than automatic.

Documentary Findings on Traditional Ecological Knowledge

Documentary analysis provided institutional and policy context for interpreting the relationship between Traditional Ecological Knowledge (TEK) and Sustainable Tourism. Reviewed tourism, conservation, wildlife, forestry, and protected-area frameworks consistently emphasized community participation, environmental stewardship, biodiversity conservation, livelihood support, and sustainable use of natural and cultural resources. Several frameworks also recognized indigenous and local knowledge as relevant to conservation and natural-resource management.

Protected-area and wildlife frameworks emphasized collaborative conservation, community engagement, environmental stewardship, and wildlife coexistence. TAWIRI frameworks recognized indigenous knowledge alongside scientific research and community participation in wildlife management, while Wildlife Management Area frameworks connected local stewardship with community participation, benefit sharing, and sustainable wildlife-resource management.

Forestry frameworks similarly linked ecosystem conservation with community livelihoods and sustainable resource use, corresponding with participants' accounts of inherited environmental knowledge and community stewardship of forests, wildlife habitats, water resources, and biodiversity. Overall, the documentary evidence indicates an institutional environment that recognizes community ecological stewardship and local knowledge as relevant to conservation and protected-area sustainability. However, these documents provide policy and institutional context rather than evidence that TEK causes Sustainable Tourism outcomes.

Mixed Methods Integration

The quantitative, qualitative, and documentary findings were integrated through side-by-side comparison and weaving to examine convergence, complementarity, qualification, and divergence in the relationship between TEK and Sustainable Tourism.

Quantitatively, TEK was positively correlated with Sustainable Tourism ($r = .607$, $p < .001$) and remained significantly associated with Sustainable



Tourism in the fully specified regression model ($\beta = .208$, $p < .001$). Qualitatively, participants connected TEK with environmental stewardship, customary resource management, wildlife coexistence, seasonal knowledge, cultural continuity, and intergenerational knowledge transmission. Documentary evidence situated these experiences within Tanzanian conservation and protected-area frameworks recognizing community participation, environmental stewardship, and local knowledge.

Integration revealed convergence around the environmental and conservation relevance of TEK and complementarity where qualitative evidence illuminated seasonal knowledge, cultural values, intergenerational transmission, and locally embedded conservation practices not fully captured by the quantitative composite. Documentary evidence further located these community experiences within the wider institutional environment.

The findings also require qualification. Both TEK and Sustainable Tourism were measured principally through respondents' perceptions; interviews represented participants' interpretations, while documentary evidence reflected institutional positions rather than realized outcomes. The integrated evidence therefore supports a statistically significant and contextually grounded association between TEK and Sustainable Tourism but does not establish causality.

Table 11. Integrated Findings on Traditional Ecological Knowledge and Sustainable Tourism

Quantitative finding	Qualitative evidence	Documentary evidence	Integration
TEK correlated positively with ST ($r = .607$, $p < .001$).	TEK was associated with environmental stewardship and sustainable resource use.	Conservation frameworks emphasized community participation, stewardship, and biodiversity protection.	Convergence: The three strands consistently associate community ecological knowledge with sustainability.
TEK remained significant in Model 3 ($\beta = .208$, $p < .001$).	Participants described customary conservation, ecosystem knowledge, and wildlife coexistence.	TAWIRI recognized indigenous knowledge alongside scientific research and community participation.	Complementarity: Qualitative and documentary evidence contextualize the adjusted TEK and ST association.



TEK recorded a very high mean ($M = 4.48$, $SD = 0.40$).	Seasonal and ecological knowledge remained embedded in community livelihoods.	Frameworks recognize community stewardship and sustainable resource management.	Convergence with qualification: TEK appears strongly embedded, but its measurement was perception-based.
ST comprised economic, environmental, and socio-cultural dimensions.	TEK was linked with cultural heritage and intergenerational knowledge transmission.	Protected-area frameworks connect conservation with community participation and local stewardship.	Complementarity: TEK's relevance extends beyond conservation to socio-cultural aspects of tourism sustainability.
Statistical analysis established association, not causality.	Interviews explained how participants perceived TEK to support sustainability.	Documents provided institutional context rather than realized outcomes.	Qualification: Integrated evidence supports a contextually grounded relationship but not causal effects.

Source: Survey Data, Key-Informant Interviews and Documentary Analysis (2025).

Discussion

The findings demonstrate that Traditional Ecological Knowledge (TEK) is significantly associated with Sustainable Tourism among communities adjacent to Arusha National Park. TEK showed a strong positive bivariate relationship with Sustainable Tourism ($r = .607$, $p < .001$) and remained significant in the fully specified regression model ($\beta = .208$, $p < .001$) after Tourism Planning, Tourism Entrepreneurship, Government Support, and the interaction term were considered. The qualitative findings further showed that this relationship was expressed through environmental stewardship, cultural continuity, intergenerational learning, wildlife coexistence, and community relationships with the protected-area landscape.

Traditional Ecological Knowledge and Environmental Sustainability

Environmental stewardship was the most prominent qualitative expression of TEK. Participants associated local ecological knowledge with the protection of land, forests, wildlife, water resources, and other natural assets on which protected-area tourism depends. This supports the understanding of TEK as accumulated, place-based knowledge that contributes to biodiversity conservation and locally adapted resource management (Berkes,



2017; Sinthumule, 2023). African evidence similarly demonstrates the continuing relevance of Indigenous and local knowledge to biodiversity conservation and community stewardship under changing environmental and socio-economic conditions (Sinthumule, 2023). This relationship is particularly important around Arusha National Park because nature-based tourism depends on the continued integrity of wildlife habitats, landscapes, forests, water resources, and biodiversity. Community ecological knowledge can therefore complement formal conservation by providing locally grounded understanding of ecosystems, seasonal change, resource use, and wildlife behavior. Similar evidence from Tanzania demonstrates the conservation importance of culturally embedded practices, including sacred landscapes and community resource stewardship (Mgumia & Oba, 2003).

The findings should nevertheless not be interpreted as demonstrating that TEK directly caused ecological improvement. The study measured community perceptions rather than changes in biodiversity, wildlife populations, forest cover, or other biophysical indicators. Consequently, the results establish an association between perceived TEK and perceived Sustainable Tourism and illuminate how communities understand that relationship, rather than demonstrating ecological causation. This distinction is important because the contribution of TEK may also be affected by resource pressures, institutional arrangements, and changing livelihood conditions.

Intergenerational Knowledge, Cultural Heritage and Socio-Cultural Sustainability

TEK also emerged as an important socio-cultural resource. Participants connected ecological knowledge with cultural identity, place attachment, inherited environmental responsibilities, and transmission of knowledge between generations. This reinforces the argument that ecological knowledge is embedded within the cultural institutions and social relationships through which communities interact with their environments (Berkes, 2017; Sinthumule, 2023). Research has similarly emphasized the importance of maintaining and revitalizing intergenerational ecological knowledge as social and environmental conditions change (Ianni et al., 2015).

For tourism, this relationship is important because cultural landscapes, environmental knowledge, traditions, and locally distinctive practices contribute to destination identity. The findings suggest that TEK can support socio-cultural sustainability by reinforcing cultural continuity, community identity, heritage preservation, and intergenerational learning. This interpretation is consistent with evidence from community-based tourism in Tanzania showing that local culture and community participation can constitute important components of sustainable destination development (Mgonja et al., 2021).



However, incorporating ecological and cultural knowledge into tourism also creates potential tensions. Guiding, storytelling, cultural interpretation, and heritage experiences may provide opportunities for cultural continuity and livelihoods, but commercialization may also commodify knowledge or reduce community control over its representation. TEK should therefore not automatically be transformed into a tourism product. Community consent, ownership, cultural sensitivity, and control over what knowledge is shared remain important conditions for sustainable use.

Traditional Ecological Knowledge, Wildlife Coexistence and Protected-Area Livelihood Tensions

An important finding was that strong ecological knowledge and support for conservation coexisted with livelihood costs associated with living adjacent to a protected area. Participants reported wildlife-related crop losses and restrictions on access to some natural resources while simultaneously recognizing the importance of conserving wildlife and landscapes for tourism and future generations. This reflects the broader protected-area challenge in which neighbouring communities may experience conservation and tourism benefits alongside significant livelihood costs (Snyder & Sulle, 2011; Nyaupane et al., 2022). The finding challenges any assumption that TEK automatically creates harmonious community and conservation relationships. Local ecological knowledge may assist communities in understanding wildlife behavior, seasonal conditions, resource availability, and appropriate responses, but knowledge alone cannot resolve structural problems such as wildlife damage, restricted resource access, unequal benefits, or limited participation in decision-making.

Consequently, the sustainability value of TEK depends partly on the institutional environment within which it operates. Protected area management that seeks to utilize community knowledge without addressing the costs borne by neighbouring communities may undermine long-term support. TEK is therefore more likely to strengthen Sustainable Tourism when ecological knowledge is accompanied by meaningful participation, recognition of community interests, equitable benefits, and appropriate mechanisms for managing human-wildlife interactions.

Economic Relevance of Traditional Ecological Knowledge

The economic relevance of TEK was less direct than its environmental and socio-cultural contribution. Local ecological and cultural knowledge may support tourism livelihoods by helping maintain wildlife, landscapes, cultural heritage, and destination identity. It may also contribute to guiding, cultural interpretation, handicrafts, heritage experiences, and other forms of community-based tourism. Community-based tourism research in Tanzania



similarly demonstrates the potential for cultural resources and local participation to support tourism-related livelihood opportunities (Mgonja et al., 2021; Snyder & Sulle, 2011).

However, the present study did not measure revenue generated specifically from TEK, household income attributable to TEK based activities, visitor expenditure associated with Indigenous knowledge, or economic multiplier effects. The findings therefore do not establish a direct economic return from TEK. Its economic relevance should instead be interpreted cautiously as a potential contribution through maintaining environmental and cultural resources and supporting tourism-related livelihood opportunities. This distinction is important because it prevents the statistically significant Traditional Ecological Knowledge and Sustainable Tourism relationship from being interpreted as evidence that TEK contributes equally or directly to every sustainability dimension. The findings suggest a particularly visible environmental and socio-cultural contribution, while the economic connection remains more indirect and requires further empirical investigation.

Interpretation through Social Exchange Theory and Cultural Ecology

Social Exchange Theory (SET) helps explain how the findings relate to community experiences of tourism and conservation. Communities adjacent to protected areas encounter both benefits and costs. Participants valued conservation, cultural continuity, tourism opportunities, and protection of resources for future generations while also experiencing wildlife related losses and restrictions on resource access. This combination is consistent with SET, which suggests that community support for tourism is influenced by perceived benefits and costs as well as wider considerations of participation, trust, and exchange (Nunkoo & Gursoy, 2012; Nunkoo & Ramkissoon, 2012).

Recognition of TEK may therefore influence how communities evaluate tourism and conservation. Where local knowledge is respected, community interests are recognized, and tourism generates valued benefits, support for conservation and tourism may be strengthened. Conversely, persistent conservation costs combined with limited participation or benefits may weaken support.

SET nevertheless provides only part of the explanation. Participants also described stewardship in terms of cultural identity, inherited responsibility, attachment to place, and obligations toward future generation's motivations that cannot be reduced to benefit-cost calculations. Cultural Ecology provides the complementary perspective by explaining how ecological knowledge develops through continuing interactions among communities, culture, livelihoods, and the environment. From this perspective, knowledge of wildlife, seasonal change, natural resources, and conservation practices forms part of communities' adaptation to and interpretation of their



local landscape. TEK is consequently dynamic rather than a fixed collection of inherited practices.

Together, the theories illuminate different aspects of the relationship. Cultural Ecology explains the ecological and cultural embeddedness of TEK, whereas SET helps explain how tourism and conservation benefits, costs, recognition, and participation shape community responses. Their complementarity is particularly useful in protected-area tourism because neither environmental adaptation nor tourism exchange alone adequately explains the relationship observed around Arusha National Park.

Institutional Recognition and the Knowledge-Practice Gap

The documentary and qualitative findings indicate an important distinction between institutional recognition of community knowledge and its practical incorporation into management. Tanzania's conservation frameworks recognize community participation, local stewardship, and the integration of different forms of knowledge, yet participants reported uneven stakeholder cooperation and continuing livelihood pressures. This suggests a potential knowledge-practice gap. Formal acknowledgement of Traditional Ecological Knowledge (TEK) does not necessarily mean that community knowledge holders influence conservation and tourism decisions. For TEK to contribute effectively to Sustainable Tourism, recognition needs to extend beyond consultation toward mechanisms through which community knowledge can inform conservation planning, human wildlife coexistence, visitor interpretation, cultural resource management, and locally appropriate tourism development. Such integration should not imply replacing scientific conservation with traditional knowledge. Rather, the findings support approaches in which locally grounded knowledge and formal conservation expertise can complement one another while recognizing the rights, experiences, and interests of neighbouring communities.

Conclusion and Recommendations

Conclusion

This study examined the relationship between Traditional Ecological Knowledge (TEK) and Sustainable Tourism among communities adjacent to Arusha National Park, Tanzania. The findings established a positive and statistically significant association between TEK and Sustainable Tourism, which remained significant after accounting for Tourism Planning, Tourism Entrepreneurship, Government Support, and the broader interaction term. The null hypothesis was therefore rejected.

The mixed-methods findings indicate that TEK is particularly relevant to Sustainable Tourism through environmental stewardship and socio-cultural



continuity. Community ecological knowledge was associated with conservation practices, sustainable resource use, seasonal knowledge, wildlife coexistence, cultural identity, and intergenerational knowledge transmission. Its economic relevance was less direct, principally through the maintenance of natural and cultural assets that support destination attractiveness and tourism related livelihood opportunities.

The study therefore concludes that TEK represents a distinct dimension of Local Community Participation associated with multidimensional Sustainable Tourism. However, its sustainability relevance is shaped by the protected area context, including institutional recognition, stakeholder collaboration, human wildlife interactions, and resource access pressures. Sustainable protected-area tourism consequently requires not only preservation of TEK but also its culturally appropriate recognition and meaningful incorporation into tourism and conservation governance.

Recommendations

Tourism and conservation institutions should establish practical mechanisms for incorporating TEK into protected area planning, biodiversity conservation, environmental monitoring, wildlife management, and community based tourism. Community knowledge holders should participate meaningfully in relevant decision-making rather than being engaged primarily through consultation.

Greater attention should also be given to intergenerational knowledge transmission. Community elders and other knowledge holders, educational institutions, conservation agencies, and tourism authorities should collaborate in locally appropriate initiatives for transmitting ecological knowledge and cultural heritage to younger generations.

Where TEK is incorporated into guiding, cultural interpretation, conservation education, or community-based tourism, its use should remain community led and respect community ownership, consent, cultural sensitivity, and restrictions on knowledge considered inappropriate for public or commercial use.

Finally, recognition of TEK should be accompanied by practical responses to the costs experienced by communities neighbouring protected areas, particularly human wildlife interactions and resource-access pressures. Recognition of local knowledge without addressing these livelihood realities may limit community support for conservation and Sustainable Tourism.

Implications for Policy and Practice

The findings suggest that protected area tourism policy should recognize neighboring communities not only as beneficiaries or participants but also as knowledge holders and destination stewards. Institutional



mechanisms are therefore needed through which community ecological knowledge can inform conservation planning, biodiversity management, visitor interpretation, and locally appropriate tourism development.

At destination level, collaborative arrangements involving community knowledge holders, local government, conservation agencies, and tourism operators could help bridge the knowledge-practice gap identified in the study. Such arrangements would enable formal recognition of Traditional Ecological Knowledge (TEK) to translate more effectively into its practical consideration within tourism and conservation management.

Areas for Future Research

Future research should examine the Traditional Ecological Knowledge (TEK) and Sustainable Tourism relationship across multiple protected areas and different ecological, cultural, and governance settings. Longitudinal studies would be particularly useful for examining changes in TEK transmission and tourism sustainability over time and for addressing the temporal limitations of the present cross-sectional design.

Further studies should investigate how TEK can be integrated with scientific conservation and contemporary destination management while protecting community ownership and cultural integrity. Research could also examine the three sustainability dimensions separately, particularly the economic relationship, which the present study suggests may be less direct than TEK's environmental and socio-cultural relevance.

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