

Governance of Ecotourist Mobility Around the SDGs in Mexico

Francisco Ruben Sandoval Vazquez¹, Alejandra Navarrete Quezada², Arturo Sanchez Sanchez³, Tirso Javier Hernández Gracia⁴ and Cruz Garcia Lirios^{5*}

¹Universidad Autónoma del Estado de Morelos, Cuernavaca, México

²Universidad Autónoma Metropolitana, Unidad Xochimilco, México

³Universidad Autónoma de Tlaxcala, México

⁴Universidad Autónoma del Estado de Hidalgo, Pachuca, México

⁵Universidad de la Salud, CDMX, México

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***Corresponding author:** Cruz Garcia Lirios, Universidad de la Salud, CDMX, México

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ABSTRACT

Ecotourism governance is a system for managing differences and co-responsibilities between the parties in conflict, but its dimensions have not been measured as derivations of the SDGs. The objective of this work was to compare the theoretical structure with the observations of this work. A cross-sectional, psychometric and correlational study was carried out with a sample of 100 students selected for their commitment to their university in the implementation of the SDGs. The results show that gender determined ecomobility, which was considered as a second-order factor and reflected in five factors related to 1) Collaborative Governance, 2) Sustainability in Mobility, 3) Community Participation, 4) Economic Impact, 5) Conservation and Environmental Management. In relation to the state of the art which warns of the impact of ecomobility in the locality, it is recommended to extend the study in order to empirically test the model.

Keywords: Governance, Ecotourism mobility, Multiple indicator & Multiple cause, Sustainable development Goals

1. Introduction

The governance of ecotourism mobility within the framework of the Sustainable Development Goals (SDGs) has undergone a significant transformation, shifting from traditional state-controlled models to more collaborative and multilateral approaches involving both public and private actors¹. This paradigm shift reflects a broader evolution in governance, emphasizing the interdependence between different levels of

government, local communities and global stakeholders in achieving sustainable tourism objectives.

The concept of governance in sustainable tourism, particularly in ecotourism, gained prominence in the 1980s and 1990s amid rising global concerns about the detrimental effects of mass tourism on the environment². These concerns were further amplified with the publication of the Brundtland Report in 1987, which introduced the concept of sustainable

development and highlighted the necessity for more responsible tourism practices.

The 1992 United Nations Conference on Environment and Development (Earth Summit) marked a turning point by establishing a foundation for sustainable tourism policies³. This milestone led to the development of regulations and practices that promote ecotourism—a tourism model designed to minimize environmental impact, respect local cultures and economically benefit host communities.

Governance theories in ecotourism have evolved from traditional hierarchical structures to participatory models that integrate diverse actors and perspectives. Three key governance dimensions in ecotourism include:

- **Multi-level governance:** Recognizing the need for coordination across different government levels (local, regional, national and international), this approach ensures the effective management of tourism impacts while incorporating local communities and tourists as active stakeholders⁴.
- **Network-based governance:** As sustainable tourism becomes a global priority, governance structures have evolved into collaborative networks where public, private and non-governmental entities work together to develop policies aligned with the SDGs⁵.
- **Community participation:** Effective ecotourism governance necessitates the direct involvement of local communities in decision-making processes. This inclusion ensures that tourism initiatives contribute to their socio-economic well-being without compromising ecological sustainability⁶.

Ecotourism mobility must be analyzed through the lens of sustainability, considering the environmental, economic and socio-cultural implications arising from tourist-destination interactions⁷. Sustainable mobility in ecotourism governance is centered on three primary areas:

- **Sustainable mobility:** One of the most pressing governance concerns in ecotourism mobility is reducing the carbon footprint⁸. Transportation remains one of the primary contributors to tourism-related emissions, necessitating policies that encourage eco-friendly transportation modes, such as cycling, hiking and other low-impact alternatives.
- **Local development and green jobs:** Ecotourism mobility presents opportunities for economic growth by creating employment in eco-friendly sectors, supporting local economies and fostering sustainable business practices⁹. This aligns with SDG 8 (Decent Work and Economic Growth) and SDG 12 (Responsible Consumption and Production).
- **Conservation and environmental management:** The governance of ecotourism is intrinsically linked to the preservation of natural resources¹⁰. Since ecotourism depends on the integrity of local ecosystems, mobility within protected areas must be carefully regulated to prevent environmental degradation.

Ecotourism governance is directly connected to several SDGs, reinforcing the need for strategic policymaking and responsible management:

- **SDG 13 (Climate Action):** Advancing tourism initiatives

that minimize carbon emissions and promote sustainable mobility is essential in combating climate change¹¹.

- **SDG 15 (Life on Land):** Ecotourism serves as a tool for biodiversity conservation, provided that tourist mobility and environmental impact are effectively managed¹².
- **SDG 11 (Sustainable Cities and Communities):** Integrating ecotourism mobility into urban and rural planning helps prevent landscape degradation and environmental harm while promoting sustainable infrastructure¹³.

The governance of ecotourism mobility is an evolving field that demands cooperation among multiple stakeholders, integration of environmental and social policies and a steadfast commitment to sustainability. By aligning ecotourism governance with the SDGs, policymakers and industry leaders can create a more sustainable, equitable and resilient tourism sector that balances economic benefits with environmental conservation (see annex A).

However, the dimensions of governance around ecotourism mobility have not been measured as an effect of the implementation of the SDGs in public universities in central Mexico. Therefore, the objective of this work was to compare the theoretical structure of ecocentric mobility with respect to the governance observed in students committed to the implementation of the SDGs at their university.

Are there significant differences between the theoretical structure of ecotourism mobility with respect to the observations made in a sample of students committed to their universities in the implementation of the SDGs?

The premise guiding this paper suggests that the implementation of the SDGs in public universities generated normative and prescriptive governance rather than instrumental governance aimed at achieving international certification. Consequently, significant differences are expected between the dimensions reported in the literature and those observed in this paper.

2. Method

Design. This study employed a cross-sectional, exploratory and psychometric approach to examine the validity and reliability of the Ecotourist Mobility Governance Scale.

A purposive sample of 100 university students was selected based on their active involvement in implementing the Sustainable Development Goals (SDGs) at their institution. The selection process followed three main criteria:

- **Active participation in sustainability projects:** Students were required to have direct involvement in university-led initiatives related to SDG implementation, ensuring that they had practical experience with governance structures in sustainability.
- **Enrollment in programs related to environmental and social governance:** Students from faculties such as Environmental Sciences, Tourism, Urban Planning and Public Administration were prioritized to align with the thematic focus of the study.
- **Representation of diverse academic levels:** Both undergraduate and graduate students were included to capture varying perspectives on sustainability governance.

The study was conducted at a public university, chosen for its central role in promoting social responsibility, sustainable

policies and community engagement. Public universities, unlike private institutions, are often key actors in government-driven sustainability efforts, making them ideal settings for studying governance models. Additionally, public institutions provide access to a diverse student body, ensuring a more representative understanding of the challenges and opportunities in implementing SDGs in higher education.

3. Sample Characteristics

- **Gender:** The sample was composed of 56% female participants, 42% male and 2% non-binary or preferred not to disclose. This distribution reflects the general demographic composition of sustainability and environmental programs in higher education.
- **Age:** Participants' ages ranged from 18 to 28 years ($M=22.4$, $SD=2.6$), ensuring representation of both undergraduate and graduate students.
- **Income level:** Based on self-reported household income, the distribution was:
 - **Low-income:** 38% (household income below the national minimum wage)
 - **Middle-income:** 47% (household income between one and three times the national minimum wage)
 - **High-income:** 15% (household income above three times the national minimum wage)

These demographic variables were considered relevant to examine potential differences in perceptions of ecotourist mobility governance, particularly regarding economic impact and accessibility of sustainable mobility initiatives.

The study was conducted at a public university, selected for its strong commitment to sustainability policies and its diverse student body, which ensures a broad perspective on governance challenges. Unlike private institutions, public universities often have greater engagement with government-led sustainability programs, making them ideal settings for studying SDG implementation.

Instrument. The study utilized the Ecotourist Mobility Governance Scale (see Annex B), which measures key dimensions of sustainable mobility governance. These dimensions include Collaborative Governance¹⁴, Sustainability in Mobility¹⁵, Sustainable Mobility¹⁴, Community Participation¹⁶, Economic Impact and Conservation and Environmental Management¹⁷. The inclusion of these dimensions reflects a comprehensive framework for evaluating governance structures that support sustainable tourism and mobility initiatives.

3.1. Procedure

Participants were contacted via their institutional email and invited to engage in a three-phase process designed to ensure the robustness of the instrument. First, they participated in a focus group discussion to qualitatively assess the relevance of the scale's variables and dimensions. Second, a Delphi study was conducted with selected experts and stakeholders to refine and validate the scale's items through iterative feedback. Finally, participants completed the survey, considering their roles as project leaders and collaborators in SDG implementation. They were informed that their responses would be used solely for research purposes, would not impact on their academic standing and that no compensation would be provided for their

participation. Participants were informed that their responses were for research purposes only, that their academic status would not be affected and that no compensation would be provided.

3.2. Reliability analysis

To evaluate the internal consistency of the scale, Cronbach's alpha (α) and McDonald's omega (ω) were computed for each dimension. A threshold of $\alpha \geq 0.70$ was considered acceptable for reliability, ensuring that the items within each dimension measured the same underlying construct. Additionally, composite reliability (CR) was assessed to verify the stability of the construct indicators over repeated measures.

3.3. Validity analysis

To ensure construct validity, confirmatory factor analysis (CFA) was conducted using the maximum likelihood estimation (MLE) method. The following fit indices were considered to confirm the model's adequacy:

- Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) (acceptable values ≥ 0.90)
- Root Mean Square Error of Approximation (RMSEA) (acceptable values ≤ 0.08)
- Standardized Root Mean Square Residual (SRMR) (acceptable values ≤ 0.08)

Convergent validity was assessed through average variance extracted ($AVE \geq 0.50$), ensuring that each construct explained a significant proportion of variance in its indicators. Discriminant validity was confirmed using Fornell and Larcker's criterion, verifying that each construct was distinct from others in the model.

Multiple Causes and Multiple Indicators (MIMIC) Model. A MIMIC model was employed to assess the influence of multiple exogenous variables on latent constructs. This approach allowed for:

- Evaluating how sociodemographic factors (e.g., age, academic background and involvement in SDG projects) influenced governance perceptions
- Detecting potential measurement biases, ensuring that different subgroups interpreted the scale consistently
- Controlling for confounding variables, improving the explanatory power of the model

Structural equation modeling (SEM) was used to estimate direct and indirect effects of exogenous variables on the dimensions of ecotourist mobility governance. Standardized path coefficients (β) and significance levels ($p < 0.05$) were reported to determine the strength of these relationships.

Including the Google Colab code for statistical analysis in an annex is essential for ensuring the transparency, reproducibility and methodological rigor of this study. Open science practices emphasize the importance of making research methodologies accessible, allowing other researchers to verify results, replicate findings and extend the study's framework to different contexts¹⁸. By providing the statistical code, this research aligns with best practices in data analysis and strengthens the credibility of its conclusions.

From a methodological perspective, the statistical analysis performed in this study involves complex computations,

including reliability and validity testing, structural equation modeling and multiple indicators and multiple causes (MIMIC) modeling. Google Colab, as a cloud-based coding platform, facilitates reproducibility by allowing researchers to run the provided scripts without requiring local software installations. This is particularly important for advanced statistical procedures, such as confirmatory factor analysis (CFA) and latent variable modeling, which require specialized packages and computational resources¹⁹.

Moreover, including the code allows future researchers to adapt the statistical procedures to their own datasets. By modifying input parameters, adjusting sample characteristics or extending the analysis with additional variables, scholars can build upon this study’s findings. This aligns with the principles of cumulative science, where research does not stand in isolation but rather contributes to a growing body of knowledge²⁰.

Additionally, the annex serves as a pedagogical tool for students and researchers who seek to learn and apply statistical methods in eco-mobility governance studies. The code can function as a step-by-step guide, demonstrating how to conduct key analyses such as exploratory factor analysis (EFA), reliability testing (Cronbach’s alpha) and structural model evaluation²¹. Providing annotated code ensures that readers understand the rationale behind each analytical step, reinforcing methodological literacy in applied research.

Table 1: Indicator coefficients.

Indicator	95% Confidence Interval					Standardized			
	Estimate	Std. Error	z-value	p	Lower	Upper	All	Latent	Endo
GC	1.813	0.089	20.400	< .001	1.639	1.987	1.012	1.815	1.012
YE	1,534	0.104	14.743	< .001	1.330	1,737	0.838	1,535	0.838
PC	1.677	0.100	16.722	< .001	1.481	1.874	0.908	1.679	0.908
IE	1,580	0.102	15.536	< .001	1.381	1,780	0.868	1,582	0.868
CGA	1.352	0.113	11.972	< .001	1.130	1,573	0.723	1.353	0.723

The structural equation modeling (SEM) results indicate that all relationships between the higher-order latent variable (eco-mobility) and its second-order factors are statistically significant ($p < 0.001$), supporting the hypothesized measurement structure. The path coefficients demonstrate both formative and reflective relationships, reinforcing the dual nature of eco-mobility as an emergent and interdependent construct (Figure 1).

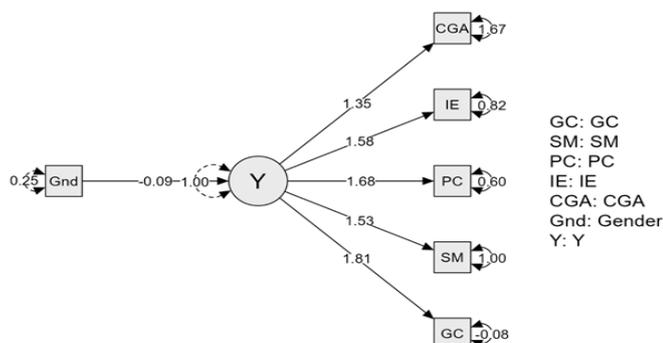


Figure 1: Model of multiple causes and indicators of ecomobility.

Findings suggest that eco-mobility is a gendered construct, meaning that perceptions and participation in sustainable mobility initiatives vary based on gender. Additionally,

Finally, the inclusion of the statistical code enhances the study’s replicability in interdisciplinary contexts. Researchers from different fields, such as environmental sciences, urban planning and public policy, can utilize the provided scripts to test governance models in their respective areas. Given the increasing role of data-driven decision-making in sustainable development, making analytical methods openly available supports cross-disciplinary collaboration and policy-oriented research²².

In conclusion, the annex with Google Colab code is a fundamental component of this study, as it fosters transparency, enhances reproducibility, facilitates methodological learning and supports future research applications. By embracing open science practices, this research contributes to a more robust and accessible framework for statistical analysis in eco-mobility governance.

4. Results

The confirmatory factor analysis (CFA) was conducted to evaluate the structure of the Ecotourist Mobility Governance Scale and assess the relationships among its latent constructs. The analysis of indicator coefficients confirms that eco-mobility is adequately represented by the factors that group its indicators (Table 1).

eco-mobility is primarily structured around five key dimensions:

- Collaborative Governance,
- Mobility Sustainability,
- Community Engagement,
- Economic Impact and
- Conservation and Environmental Management.

Model fit indices indicate an excellent model fit, confirming the robustness of the proposed structure:

- Chi-square test: $\chi^2=1080.092$, $\chi^2=1080.092$ (15 df), $p > 0.001$
- Relative Fit Index (RFI): 0.998
- Standardized Root Mean Square Residual (SRMR): 0.006

These values suggest that the hypothesis regarding significant differences between the dimensions and determinants of the eco-mobility structure cannot be rejected. The low residual values and high goodness-of-fit indices confirm that the proposed model adequately represents the observed data, supporting the validity of the eco-mobility construct.

5. Discussion

The contribution of this study lies in the establishment of a

Multiple Causes and Multiple Indicators (MIMIC) model, in which gender is identified as a determinant of eco-mobility, which, in turn, is reflected by five interrelated factors:

- Collaborative Governance,
- Sustainability in Mobility,
- Community Participation,
- Economic Impact and
- Conservation and Environmental Management.

Ecotourism is widely recognized as a growing industry focused on sustainable travel and environmental conservation²³. A key issue within this field is the impact of tourist mobility on the environment, particularly due to air transport, which significantly contributes to carbon emissions. This has been extensively studied in regions like the Himalayas, where eco-tourism activities such as trekking generate a notable ecological footprint. However, while previous research has centered on regional case studies²⁴, this study shifts the focus to eco-mobility governance at the institutional level, providing a broader policy-oriented perspective.

Recent works highlight the role of technological innovations in reducing the ecological impact of mobility. For example, smart mobility solutions, such as connected bicycles for hotels, have been proposed to enhance sustainable travel²⁵. Similarly, the rise of e-tools and mobile applications has facilitated citizen engagement in sustainable travel practices²⁶. While these studies emphasize technological advancements, they often overlook the governance mechanisms necessary to institutionalize eco-mobility policies, an aspect this research seeks to address.

Another dominant theme in ecotourism literature is its impact on rural development. Studies suggest that eco-tourism initiatives can foster local economies and transform landscapes²⁶. However, these analyses primarily focus on economic and social aspects without integrating them into a comprehensive governance framework aligned with the Sustainable Development Goals (SDGs). Unlike prior research, this study positions eco-mobility as a governance issue, exploring its institutional determinants rather than treating it as an isolated market-driven phenomenon.

While much of the existing literature examines the localized environmental and economic impacts of ecotourism, this study introduces a governance model rooted in SDG principles, expanding the discourse beyond individual initiatives to institutional policies that regulate eco-mobility.

A major area of opportunity identified in this research is the need to quantify the impact of eco-mobility through emission data and sustainability metrics. Future studies should extend this model by incorporating quantitative assessments of ecotourism's contribution to local carbon footprints, thereby strengthening the empirical foundation of the eco-mobility governance framework.

This study contributes to the field of eco-mobility governance by proposing a Multiple Causes and Multiple Indicators (MIMIC) model, in which gender is identified as a key determinant of sustainable mobility. Unlike previous research that has focused on localized environmental impacts^{23,24}, this study integrates institutional governance mechanisms aligned with the Sustainable Development Goals (SDGs). The findings highlight the importance of collaborative governance, mobility

sustainability, community participation, economic impact and environmental conservation in the formulation of eco-mobility policies. These insights provide a theoretical foundation that can be used in decision-making processes within higher education institutions and public administrations, offering a strategic framework for urban planning and sustainable tourism management.

However, the study presents some limitations that should be considered. First, the sample, consisting of 100 university students, limits the generalizability of the results to broader populations. Future research could expand the sample size and diversity to validate the model in different socioeconomic and cultural contexts¹⁶. Second, the study's cross-sectional design prevents an analysis of how eco-mobility practices evolve over time. Longitudinal studies would allow for the evaluation of causal relationships and the long-term impact of policies¹⁷.

Another important limitation is the absence of direct environmental impact measurements. While the study analyzes governance structures, it does not include data on carbon emissions, ecological footprints or energy consumption patterns. Incorporating quantitative environmental indicators would strengthen the empirical validity of the proposed model²⁶. Additionally, the role of technological innovations in sustainable mobility, such as electric vehicles, shared mobility platforms or AI-driven solutions, was not considered. Future research should examine how these emerging technologies interact with governance structures to promote sustainable mobility²⁵.

Based on the findings and identified limitations, several research directions are suggested. One recommendation is the application of the eco-mobility governance framework in different types of organizations, including private sector enterprises, municipal governments and non-governmental organizations, to explore variations in management strategies. Additionally, the incorporation of quantitative methodologies such as carbon footprint analysis, life cycle assessments and geospatial analysis is recommended to measure the real impact of eco-mobility policies²⁴.

Another relevant research direction is the analysis of socioeconomic determinants of eco-mobility, exploring the role of variables such as income level, education and cultural factors in the adoption of sustainable mobility practices. This would provide a more precise understanding of equity and accessibility in sustainable mobility initiatives¹⁶. Finally, given the increasing digitalization of mobility systems, future studies should evaluate the impact of technologies such as AI-driven mobility platforms, mobile applications for citizen participation and smart city solutions on eco-mobility governance²⁶.

Developing these research lines will strengthen the empirical foundation of eco-mobility governance, contributing to the formulation of more effective and sustainable policies at both local and global levels²⁷⁻³⁰.

6. Conclusion

This study has provided valuable insights into the governance of eco-mobility by proposing a Multiple Causes and Multiple Indicators (MIMIC) model that identifies gender as a key determinant of sustainable mobility. Unlike previous research that primarily focuses on the localized environmental impacts

of tourism and mobility, this study integrates a governance perspective aligned with the Sustainable Development Goals (SDGs). The findings highlight the relevance of collaborative governance, mobility sustainability, community participation, economic impact and environmental conservation as fundamental dimensions in shaping eco-mobility policies.

The results suggest that eco-mobility governance is not only a matter of individual behavioral choices but is also influenced by institutional frameworks, social structures and environmental policies. The study's empirical approach, though limited to a sample of university students, provides a foundation for future research to expand the model to different populations and institutional contexts. Additionally, the structural analysis confirms the formative and reflective relationships of eco-mobility, reinforcing the need for a multidimensional approach to sustainable mobility governance.

However, the study also presents several limitations, including the restricted sample size, the cross-sectional nature of the data and the absence of direct environmental impact measurements. Addressing these limitations in future research will be essential to refining and expanding the proposed model. Longitudinal studies, larger and more diverse samples and the integration of quantitative environmental indicators will provide a more comprehensive understanding of eco-mobility governance.

In conclusion, this study contributes to the growing body of literature on sustainable mobility by emphasizing the importance of governance mechanisms and institutional policies in promoting eco-mobility. Future research should continue exploring the socioeconomic, technological and environmental factors that shape eco-mobility, ensuring that policies and initiatives align with global sustainability objectives. Strengthening governance structures and incorporating technological innovations will be key to developing more effective and inclusive eco-mobility strategies in the coming years.

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Annex A

Table 1. Comparison of ecotourism mobility governance around the SDGs.

Dimension	Governance	Related SDG	Key Actions
Environmental	Implementation of regulations to protect fragile ecosystems. Regulation of tourism in protected areas.	SDG 13, SDG 15	- Control of access to nature reserves - Management of the carrying capacity of destinations - Promotion of the use of clean energy
Social	Participation of local communities in decision-making. Ensuring that economic benefits reach the communities.	SDG 1, SDG 8, SDG 11	- Promotion of local jobs in the ecotourism sector - Inclusion of indigenous communities in planning - Equal access to economic opportunities
Economic	Regulating economic growth that benefits both sustainability and job creation.	SDG 8, SDG 12	- Promote sustainable consumption and production practices - Implementation of policies that encourage sustainable local tourism
Infrastructure and Transport	Development of ecological and sustainable infrastructure that promotes low environmental impact transportation.	SDG 9, SDG 11	- Creation of ecotourism routes that use electric or low-emission transport - Investment in sustainable infrastructure
Education and Awareness	Governance oriented towards educational programs that promote respect for the environment and local cultures.	SDG 4, SDG 12	- Awareness campaigns for ecotourists - Inclusion of educational modules in guided tours of protected areas
Technology	Using technology to improve tourism management and mitigate impacts. Monitoring environmental impacts.	SDG 9, SDG 17	- Implementation of real-time visitor monitoring systems - Use of digital platforms to educate about sustainability
Public Policies	Creation of regulatory frameworks that promote sustainable ecotourism and incentives for green businesses.	SDG 16, SDG 17	- Establishment of tax incentives for sustainable tourism operators - Environmental protection policies in tourist destinations

Source: Elaborate with literature review.

Annex B

Objective of the instrument: To evaluate the degree to which governance practices around ecotourism mobility within a Mexican public university are aligned with the SDGs, identifying the level of implementation and effectiveness in terms of sustainability and community development.

Dimensions and Variables to Measure:

1. Collaborative governance

- Coordination between levels of government (local, state, national)
- Participation of actors (academics, students, university authorities, external organizations)
- Existence of institutional policies and regulations
- Transparency in decision making

2. Sustainability in mobility

- Use of sustainable means of transport within the campus (bicycles, public transport, walking, etc.)
- Strategies for reducing the carbon footprint in university ecotourism
- Promotion of sustainable mobility in educational programs

3. Community participation

- Inclusion of local communities in ecotourism activities promoted by the university
- Students' perception of their participation in sustainable mobility initiatives
- Cooperation with non-governmental organizations or community groups

4. Economic impact

- Promoting green jobs and economic opportunities for local communities through ecotourism
- Support for small local businesses by the university or ecotourism programs
- Generation of income derived from ecotourism mobility for the university community

5. Environmental conservation and management

- Impact of ecotourism mobility in protected natural areas near the campus
- Environmental conservation practices derived from the implementation of ecotourism programs
- Proper waste management in ecotourism activities

Questionnaire Structure:

Each dimension will be addressed through a series of items in Likert scale format (1: Totally disagree to 5: Totally agree), open-ended and multiple-choice questions. Below is an example for each dimension:

Dimension 1: Collaborative governance

1. To what extent do you think that the actors involved in planning ecotourism mobility at the university (authorities, professors, students, organizations) collaborate with each other?

- (1) Very low collaboration
- (5) Very high collaboration

2. There are clear policies in the university that promote sustainable mobility in line with the SDGs.

- (1) Totally disagree
- (5) Totally agree

3. Decision-making related to ecotourism mobility is transparent and accessible to all stakeholders.

- (1) Totally disagree
- (5) Totally agree

Dimension 2: Sustainability in mobility

1. The university has implemented effective initiatives to promote the use of sustainable means of transport (such as bicycles or public transport).

- (1) Totally disagree
- (5) Totally agree

2. Ecotourism activities organised by the university contribute to reducing the carbon footprint of participants.

- (1) Totally disagree
- (5) Totally agree

3. What type of sustainable transport has the university used or promoted in its ecotourism activities?

- () Bicycles
- () Public transport
- () Walks
- () Others (specify)

Dimension 3: Community Participation

1. Local communities actively participate in the planning and implementation of ecotourism activities organized by the university.

- (1) Totally disagree
- (5) Totally agree

2. Students have clear opportunities to participate in decisions about ecotourism mobility within the campus.

- (1) Totally disagree
- (5) Totally agree

3. What ecotourism activities with community participation have been promoted at the university in the last year?

- () Guided nature tours
- () Reforestation programs
- () Others (specify)

Dimension 4: Economic impact

1. Ecotourism mobility organized by the university generates economic opportunities for local communities (employment, sale of products, etc.).

- (1) Totally disagree

- (5) Totally agree

2. The university actively supports local small businesses as part of its ecotourism activities.

- (1) Totally disagree

- (5) Totally agree

3. In your opinion, how could the university enhance the positive economic impact of its ecotourism activities on local communities?

(Open answer)

Dimension 5: Environmental conservation and management

1. Ecotourism mobility within the protected areas near the university is managed sustainably.

- (1) Totally disagree

- (5) Totally agree

2. There are adequate mechanisms to manage the environmental impact of ecotourism promoted by the university.

- (1) Totally disagree

- (5) Totally agree

3. What types of conservation measures has the university implemented to reduce the environmental impact of ecotourism activities?

- () Waste management

- () Habitat restoration

- () Reduction in the use of plastics

- () Others (specify)

Appendix B

Installing required libraries in Colab

```
!pip install pandas numpy odpy pingouin matplotlib seaborn
```

Import necessary libraries

```
import pandas as pd
```

```
import numpy as np
```

```
import seaborn as sns
```

```
import matplotlib.pyplot as plt
```

```
import pingouin as pg
```

Carry he SDG file

```
file_path = '/content/SEM MCFI EcoMovilidad.ods '
```

```
data = pd.read_excel ( file_path , engine=' odf '
```

Show the first rows of the dataset to understand its structure

```
data.head ()
```

Review column names and data types

```
print ( data.info ( ))
```

Clean data if necessary (example of handling null values)

```
data_cleaned = data.dropna () # Remove rows with missing data
```

```
print ( data_cleaned.info ( ))
```

Exploratory analysis: descriptive statistics of the indicators

```
print ( data_cleaned.describe ( ))
```

Correlation analysis to understand the relationship between variables

```
corr_matrix = data_cleaned.corr ( )
```

```
print ( corr_matrix )
```

Visualizing the correlation matrix

```
plt.figure ( figsize =(10, 8))
```

```
sns.heatmap ( corr_matrix , annot =True, cmap =' coolwarm ', fnt =' .2f')
```

```
plt.title ('Correlation Matrix')
```

```
plt.show ()
# Analysis example: Principal Component Analysis (PCA) or SEM
from sklearn.decomposition import PCA
# Data normalization (optional)
data_scaled = ( data_cleaned - data_cleaned.mean ( ) ) / data_cleaned.std ( )
# Apply PCA
pca = PCA( n_components =2 ) # Adjust the number of components to whatever is needed
principal_components = pca.fit_transform ( data_scaled )
# Create a dataframe with the main components
pca_df = pd.DataFrame ( data= principal_components , columns =['PC1', 'PC2'])
# View the main components
plt.figure ( figsize =(8, 6))
sns.scatterplot ( x='PC1', y='PC2', data= pca_df )
plt.title ( 'Principal Components Plot' )
plt.show ()
# Factor analysis: Kaiser-Meyer- Olkin (KMO) and Bartlett tests
from pingouin import multivariate_kmo , bartlett
# KMO Test
kmo_test = multivariate_kmo ( data_cleaned )
print( "KMO Test:", kmo_test )
# Bartlett's test
bartlett_test = bartlett( data_cleaned )
print( "Bartlett's test:", bartlett_test )
```