

# **Sustainable Management Proposal for the Tourist Service in Pozuzo Through Structural Equations**

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## **Abstract**

Tourism, a crucial element for Peru's identity and economy, constitutes 2.2% of the Gross Domestic Product (GDP); However, this contribution is affected by tourist activities that generate adverse environmental impacts in the Pozuzo-Oxapampa-Peru tourist area (ecosystem). The main objective of the research is to develop a mathematical model of Structural Equations (SEM), through the SPSS software IBM AMOS, which allows measuring the impact of implementing an Environmental Management System (EMS) in accordance with the ISO-14001 standard. :2015. in the ecosystem, with the purpose of evaluating the change in tourists' habits, applying good environmental practices during tourist activities. Likewise, Leopold Matrix was used on two times, initially to obtain an environmental diagnosis. 221 people were surveyed, including tourists, residents and lodging owners, reaching a total impact result of -925. Subsequently, considering an implementation of the EMS, a value of -507 was obtained. The mathematical model found shows that there is a strong correlation of 0.74 between the implementation of the EMS and the conservation of the ecosystem. It was found that the implementation of the EMS has a positive impact on tourism activities of 0.55. At the same time, a strong correlation of 0.90 was verified between the EMS and ecosystem.

## **Keywords**

Structural Equations Model, Environmental Management System (EMS), environmental impact, tourist activities, ecosystem

## **1. Introduction**

At present, the application of sustainability has become increasingly necessary across various sectors and domains, driven by the escalating collateral effects of environmental pollution stemming from human activities worldwide. However, these activities are essential for the economy. One of the key economic sectors in Peru is tourism, contributing around +2.2% to the total GDP (El Peruano 2023). In this context, this research focuses on the following premise: 'An ecologically healthy environment and the solid development of tourism are complementary, and the degradation of the ecological environment will, in turn, affect the sustainable development of tourism' (Zhang et al. 2023). Additionally, it is considered that 'Environmental damages such as air, water, and soil pollution have a direct and indirect effect on the company's workforce, the community, and the ecosystem' (Prasad & Suresh 2023). Similarly, a direct relationship is acknowledged between environmental and economic performance, as the cost of environmental impact results in increased budgetary allocation and reduced competitiveness (Avalos Ortecho 2018). It is noteworthy that Peru boasts numerous tourist destinations, one of which is Pozuzo, an Austro-German colony

located in the province of Oxapampa, Pasco region. This area features anthropic zones, indicating variations due to human activities. Figure 1 depicts the geographical map of Pozuzo, characterized by an average annual precipitation of 2300 mm, crucial in understanding the rainfall in this area, thereby informing about rainfall and the tropical climate (Mena 2010).



Figure 1. Map of Pozuzo. Source: (Google Maps 2023)

Pozuzo offers a variety of festivities, such as the 'Pozuzo Fest' held in September, a celebration honoring its famous craft beer in the district that represents Austro-German culture (World Tourism Organization 2023). However, this city currently lacks a proper sustainable management system to mitigate the impacts generated by pollution and ecosystem deterioration caused by residents and tourists, which could directly affect long-term interests, potentially reducing tourist attraction. Furthermore, it's important to highlight its relation to experiential and adventure tourism, representing a growing market niche increasingly intertwined with other travel forms, including wellness tourism and ecotourism. Globally, the development of these three niche tourism forms is growing faster than the average global growth rate (Hunt & Harbor 2019).

### **1.1 Objectives**

The general objective of the project is to provide a sustainable management proposal for the tourist service in Pozuzo through structural equations, whose development consists of the implementation of various engineering tools to reduce environmental impacts in the town. Objective 1: Prepare background and state of the art of the project.

Objective 2: Analyze and diagnose the problem using the Leopold matrix tool.

Objective 3: Identify the variables that determine sustainability in tourism activity.

Objective 4: Validate the correlation between variables using the Cronbach's Alpha tool with the use of IBM SPSS software

Objective 5: Carry out the structural equation model, development of constructs and interrelated hypotheses using SPSS AMOS software.

Objective 6: Validate the sectoral solution proposals and evaluate the economic viability of the project

### **2. Literature Review**

To determine the environmental impact, the Leopold Matrix was utilized to diagnose Pozuzo's current ecosystem. It is 'the first method designed to assess the environmental impact of projects or activities, consisting of an interactive matrix displaying activities on one axis and environmental surroundings, factors, or affected components on the other axis' (Maldonado-Oré & Custodio 2020). This matrix requires prior reliability analysis of the provided information regarding the environment and tourist activities, i.e., environmental impacts (Rebolledo Dujisin 2020). Additionally, personal interviews were chosen as the data collection method, based on a structured questionnaire (del Río et al.

2017), with a total sample of 221 individuals including residents, tourists, and entrepreneurs, aimed at obtaining quantifiable data for this research. Likert scale was used to assess respondents' answers, 'a widely used psychometric scale in questionnaire-based research, establishing a rating range from 1 to 5, considering 5 as 'Completely Agree' and 1 as 'Completely Disagree' based on questions about the current state of Pozuzo's ecosystem. It is the most frequently used approach for measuring survey responses' (Anjaria 2022). Respondents' answers were validated using Cronbach's Alpha coefficient (Maqbool & Amaechi 2022). The survey was employed to estimate the environmental impact of tourist activities in Pozuzo, preceded by a reliability analysis to understand item coherence within the group. Reliability is the degree to which the measurement procedure yields consistent results when similar. Basically, it calculates the average of all possible reliability coefficients divided by half. A calculated alpha coefficient will vary between '1' (indicating perfect internal reliability) and '0' (indicating no internal reliability). According to Sekaran & Bougie 2010, reliabilities below 0.60 are generally considered poor, and values of 0.60 or above are considered good (Bhuiyan et al. 2021)

Furthermore, the implementation of an Environmental Management System (EMS) is considered a beneficial tool for organizations aiming to integrate environmental management into the overall corporate management system, not only to comply with existing regulations but also to consider and eventually respond to changes in knowledge and technology (Rusko et al. 2014). In this regard, the use of EMS through Structural Equation Modeling (SEM) was proposed, which offers 'a multivariate analysis allowing estimation, evaluation, and confirmation of the constructed model based on the hypothetical relationships among latent factors, employing structural equation modeling (SEM)' (Ruíz et al. 2014). SEM was introduced to explore indicators influencing and ensuring objectivity in indicator selection (Kim et al. 2023). This model follows a statistical methodology graphically representing a series of structural equations representing a hypothetical model.

Subsequently, this hypothetical model is statistically tested to determine its coherence with data (Dasanayaka et al. 2022), allowing the measurement of simultaneous relationships occurring among a set of independent variables and a set of dependent variables, eventually identifying causal relationships between latent variables (Pulido-Fernández et al. 2019). Moreover, it's considered the most appropriate method as it is a family of statistical models seeking to explain relationships between multiple variables (Liu et al. 2023). SEM can also be applied in ecology to connect empirical data with interconnected factors within a conceptual model (Maaz et al. 2023). It will thus provide an abstraction of the reality, as yet unknown in terms of outcomes, based on the reference to endogenous and exogenous variables and the relationship represented in the SEM model structure. IBM SPSS AMOS version 26 software will complement this task, a powerful tool for analyzing and validating complex models derived from questionnaire development, previously evaluated by Cronbach's coefficient. Relevant constructs related to the topic and the hypotheses linking them closely were established (Pizarro Romero & Martínez Mora 2020).

'The Environmental Management System (EMS) based on ISO 14001 provides a detailed route to develop the environmental program and establishes procedures, work instructions, and controls to ensure the implementation of the policy and achievement of objectives become a reality' (Uribe & Bejarano 2013). As a significant strategic measure of green governance, ISO14001 is closely related to the entire process of business production and operation. Therefore, to gain ecological competitive advantages, companies would actively implement ISO14001 to continuously improve environmental management activities. Hence, an environmental management system (EMS) applied in this place would keep companies at the forefront. Furthermore, ISO 14001 and the Eco-Management and Audit Scheme (EMAS) have become one of the most widely used strategies to address environmental issues (Daddi et al.,2022). Over the past decades, the growth of green sustainable responsibility to protect the environment and people has been evident, imposing strict responsibilities on organizations, communities, and the government. ISO 14001 certification provides and leads from its implementation a path for reducing pollutants that directly affect the ecosystem, such as water, air, among others, through joint efforts for sustainable development (Ofori et al. 2023). However, this measure presents a series of constraints, including significant investment, lack of adequately trained personnel, prior knowledge in such systems, and false expectations regarding the scope of EMS (Beck Schildt et al. 2023).

To carry out the sectoral project, it was necessary to understand, through indicators, the current situation in Pozuzo to perform a comparative analysis after the proposed implementation. Moreover, it's essential to consider what could emerge from the application of an environmental management system, which can be understood through the inputs and outputs described in Figure 2

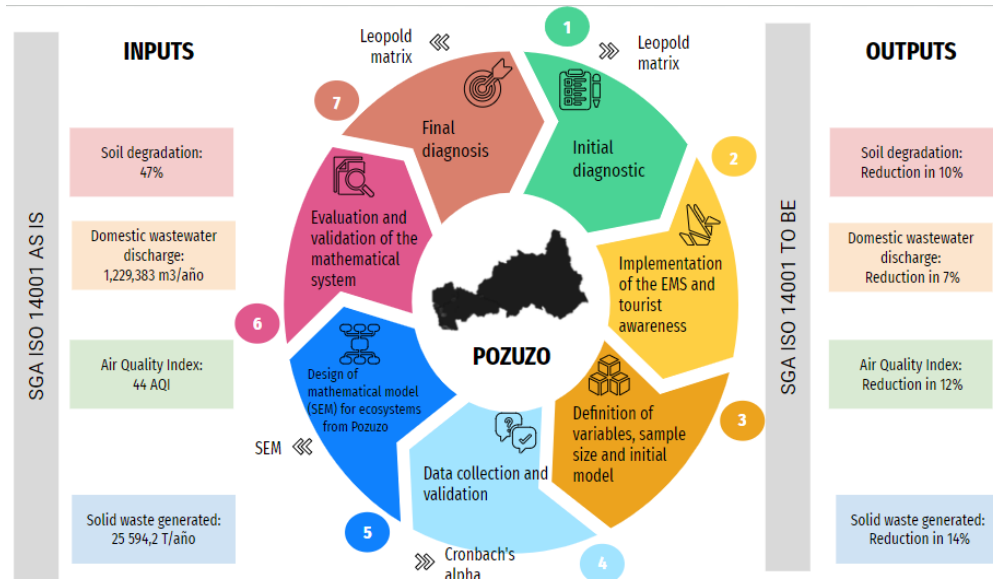


Figure 2. Model to reduce the impact of the tourism sector in Pozuzo due to environmental pollution

In summary, the question this research aims to address based on the stated problem is as follows: Is the design of a mathematical model with structural equations to evaluate the impact of the Environmental Management System on the ecosystem of Pozuzo due to tourist activities viable?

### 3. Methods

The district of Pozuzo is located in Oxapampa, within the department of Pasco, and has a population of approximately 9,759 inhabitants (INEI 2023). Around 221 respondents were evaluated, including tourists, residents, and entrepreneurs. Each survey consisted of 56 questions covering 22 variables. Following the survey, the collected information was validated using means and standard deviations to identify dispersion among responses. This factorial range provided the relationship between items and constructs, thereby confirming their validity (Allahham et al. 2024). Por otro lado, tras los cambio de la ley del Decreto Legislativo N°1501 sobre las disposiciones para la segregación, el Ministerio del Ambiente (MINAM) junto al Ministerio de Comercio Additionally, following the amendments to Legislative Decree No. 1501 concerning provisions for segregation, the Ministry of the Environment (MINAM) in conjunction with the Ministry of Foreign Trade and Tourism (MINCETUR) have been implementing a new waste management initiative since 2020. 'This initiative aims to strengthen capacities and clarify doubts regarding waste management, emphasizing regulations and prohibitions on single-use plastic bags, straws, and Styrofoam containers in tourist areas, particularly in protected natural areas (PNA), areas declared as cultural heritage or natural heritage of humanity, coastal beaches, Peruvian Amazon beaches, as well as in museums and other related establishments' (MINAM 2020), aligning with the objectives of this research.

The structure of the SEM model is presented to closely approximate reality, incorporating the evaluation indices and indicators presented earlier. The effects of implementing the EMS on identified environmental impacts were identified to analyze the relationship between different types of tourist activities and their environmental aspects within the ecosystem. Based on this, the following hypotheses are proposed.

H1: The implementation of the EMS has a positive effect on tourist activities

H2: Tourist activities regulated by the EMS reduce the dimension of impacts, consequently diminishing negative effects on the physical aspects of the ecosystem.

H3: Tourist activities executed with environmental responsibility have a positive effect on the biological component of the Pozuzo ecosystem

H4: Tourist activities implemented with EMS ISO 14001:2015 have a positive effect on the physical component of the Pozuzo ecosystem

H5: Tourist activities adhering to the criteria of EMS ISO 14001:2015 have a positive effect on the biological component of the ecosystem.

H6: The EMS has a positive influence on ecosystem protection

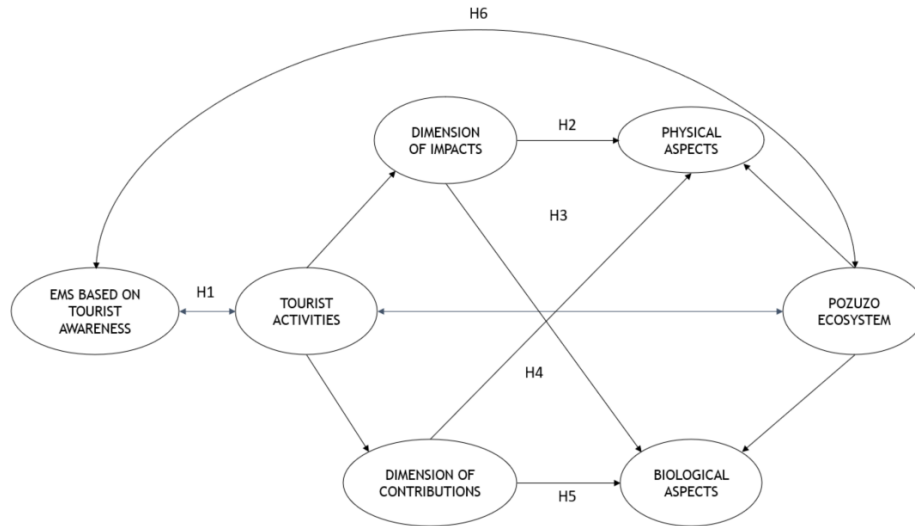


Figure 3 . Model SEM structure

#### 4. Data Collection

The application of EMS suggests that tourist companies can become certified. It is known that larger and more profitable companies are better positioned to bear the costs of initial certification, which can range between \$24,000 and \$128,000 (McGuire 2014).

Regarding the economic evaluation of the project, initially, it's essential to understand the revenues generated by tourist companies located in Pozuzo. However, relevant information specific to this case is not available. Therefore, data from another reference location in Oxapampa-Pasco, called Huayllay, was considered. Table 1 details the annual income generated by a tourist company. For calculations, the data was sourced from the Ministry of Foreign Trade and Tourism, as well as from a tourist company named Turismpoi.pe:

Table 1: National park arrival income table

Arrival at Huayllay National Park					
Year	2018	2019	2020	2021	2022
Number of tourists	292,140.0	33,217.0	7,209.0	25,961.0	49,419.0
Cost per tour	27,753,300.0	3,155,615.0	684,855.0	2,466,295.0	4,694,805.0
Income	27,753,300.0	3,155,615.0	684,855.0	2,466,295.0	4,694,805.0

Source: (Ministerio de Comercio Exterior y Turismo, 2023)

In a second instance, the implementation of an environmental management system can be a viable proposal in the development of various areas, as described in the case of China by Mengxue Ji, where it is mentioned that a vertical environmental management system and companies can generate a positive impact that could be replicated in other cases (Ji et al. 2023)

Therefore, understanding the cost of certification with ISO 14001 is crucial. Within the EMS application, the proposal for tourist companies to become certified is mentioned. As described earlier, the cost can be around 90,000.00 soles

for a small company. The training cost is approximately 1195 soles. When considering around 20 registered companies in the National Superintendence of Customs and Tax Administration (SUNAT), the total cost would amount to 1,823,900.00 soles, a figure considerably lower than the income of the companies and a cost that the municipality of Oxapampa could cover. Regarding the content of the surveys, the structure of the questions was established to resemble an equation, aiming for versatility and subjectivity in the work, combining a dependent variable (y) and an independent variable (x). Below, Table 2 presents the dependent and independent variables employed:

Table 2: Brief description of variables

X	Brief description
Playful activities	Games and activities that take place on site
Typical dance	Typical dances
Closing parties	traditional festival
Feeding	Nutrient substances for the body typical of the place
automobile traffic	Go or pass from one point to another on public roads or places
Natural attractions	Activity or fact of traveling for pleasure
Y	Brief description
Soil erosions	Wear of the earth's surface
Organic waste	That which results from the decomposition of something
Inorganic waste	That which results from the decomposition of something without organs
Fauna	Limitation of the number of animals
Flora	Set of local plants
Environment	Relative to the environment
Increase in the employment rate	Increase in employment rate
Dust particle lifting	Dust caused by transportation in Pozuzo
Excess noise	Noise caused by various activities
Water quality	Properties of water to define its value
Solid waste in water	Particles in water
Soil compaction	Soil deterioration due to human activity
Contribute to culture	Sets of ways of life, customs and knowledg

These are quantifiable indicators that can measure certain ecological parameters, such as soil degradation, discharge of domestic wastewater, air quality index, and generated solid waste, following the implementation of the EMS. Identifying the effects of EMS implementation requires specific indicators, which are shown in Table 3.

Table 3: Indicators before the implementation of the EMS

Indicators
Soil degradation
Domestic wastewater discharge
Air quality index
Solid waste generated

Additionally, 'Structural Equation Modeling was used to test the integrated study model to obtain correct and unbiased path coefficients' (Gautam, 2020). Among the variables represented in Table 4, each one is accompanied by its respective code

Table 4: Evaluation index table

Evaluation index	Variable	Code	Evaluation index	Variable	Code
Impact dimension	Soil erosions	DI01	EMS based on tourist awareness	Environmental Commitment	SGA01
	Solid waste	DI02		Social responsibility	SGA07
	Excess noise	DI03		Degree of commitment	SGA08
	Animal decline	DI04			
	Solid waste	DI05			
Physical aspects	Soil	AF01	Pozuzo Ecosystems	Water quality	EP01
	Water	AF02		Air quality	EP02
	Atmosphere	AF03		Soil quality	EP03
Biological aspects	Fauna	AB01			
	Flora	AB02			
Contribution dimension	Increase in the employment rate	DA01			
	Contribution to culture	DA02			
	Incentive for environmental care	DA03			
Tourist activities	Swimming	AT01			
	Trekking	AT02			
	automobile transport	AT03			
	Visit to tourist attractions	AT04			

Thus, the data is satisfactorily validated using the Cronbach's coefficient. According to the analysis provided by the SPSS software, it displays the summary of case processing and a resulting reliability coefficient of 0.822 (Thamilarasan et al. 2023)

### 5. Results and Discussion

The Maximum Likelihood method was employed for parameter quantification using a series of indicators that evaluated the model fit, such as the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI) (Alonso & Roque, 2023). Additionally, parameters like Chi-square and model recursion were considered. The use of the Chi-square statistic,  $X^2$ , involves a homogeneity analysis aiming to test the variation among estimated correlations. If  $X^2$  is not significant, the estimated effects among primary studies are homogeneous. However, it is essential to search for moderating variables to explain latent reasons for heterogeneity in effect size estimations among studies if  $X^2$  is significant (Hai et al. 2023).

Tabla 5: Result of SEM model fit indices

Fitting Measurements	
Chi-cuadrado	312.48
CMIN/DF	1.476
CFI	0.781
TLI	0.805
NFI	0.798
RMSEA	0.062
Model	Recursive

These measures are reflected in Figure 3.

Moreover, it's crucial to note that the sample size plays a significant role in ensuring the model demonstrates adequate fit. Thus, a total of 234 individuals were surveyed, employing the same criteria for the target population, encompassing a total of 69 questions, 23 variables, and 7 constructs.

However, it's important to note that 'To reject this hypothesis, the observed result must be associated with the p-value. The p-value ranges between 0 and 1; higher values DO NOT reject the null hypothesis.' (Escobedo Portillo et al. 2016)

### 5.1 Numerical Results

According to the results of the Leopold Matrix, a significant reduction in environmental impacts is identified and in this way the viability of the Environmental Management System is validated. Comparing with the first diagnosis, Table 6 is presented, which shows the comparison of results.

Table 6: Results showdown table

Subfactors	First Leopold Matrix	Second Leopold Matrix
Soil	-733	-637
Water	-147	-123
Atmosphere	-253	-190
Fauna	-197	-145
Flora	-72	-65
Economic-social	658	778
Total impacts	-925	-507

### 5.2 Graphical Results

Likewise, this research will require the use of a second validation tool, which will involve the creation of a second Leopold Matrix to quantify the environmental impacts that may result from the initial tourist activities after implementing the proposed best practices. Following data validation procedures, responses were checked using the Cronbach's Alpha validation coefficient, resulting in a score of 0.848, thereby strengthening the survey's validity.

For Structural Equation Modeling (SEM) to verify the conceptual model and proposed hypotheses, the maximum likelihood estimation method was employed, initialized using IBM SPSS AMOS 26 software (Sirola et al.2023).

“This cluster selection is corroborated with the multivariate technique of principal component analysis, a Kaiser, Meyer, and Olkin (KMO) correlation matrix analysis, and Bartlett's sphericity test.”(Gallego & Araque 2019). This analysis was conducted to identify if the obtained data has the capacity to correlate its factors (Pizarro Romero & Martínez Mora 2020).Based on the analyses presented, it is concluded that structural equations will present an appropriate model to study the relationship between the Environmental Management System and its impact on the ecosystems of Pozuzo according to the variables analyzed. Figure 4 illustrates the final model, presenting the statistical values of each variable.



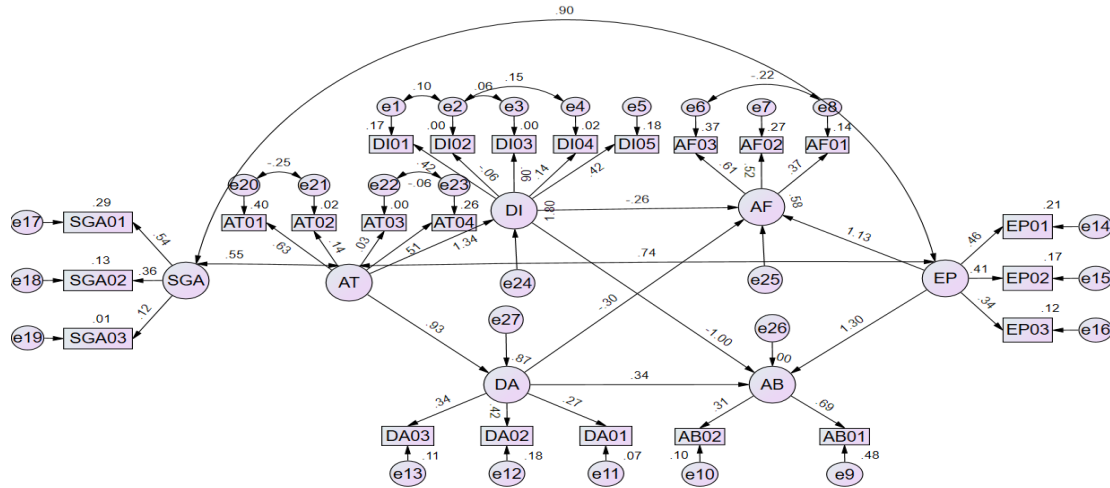


Figure 4. Mathematical model of structural equations

**5.3 Proposed Improvements**

The six hypotheses were tested by evaluating the causal pathways among the constructs, of which three were found to be significant, while the others were rejected. The values are presented in Table 7. (Nassani et al., 2023).

Table 7: SEM model hypothesis results table

Hypothesis	Path relationship	Path coefficient (M)
H1	The implementation of the EMS has a positive effect on tourism activities. The implementation of the EMS does not have a positive effect on tourism activities.	0.55
H2	Tourist activities regulated by the EMS reduce the dimension of impacts and these reduce the negative effects on the physical aspects of the ecosystem. The tourist activities regulated by the EMS do not reduce the dimension of impacts and these reduce the negative effects on the physical aspects of the ecosystem.	-0.26
H3	Tourist activities carried out with Environmental responsibility have a positive effect on the biological component of the Pozuzo ecosystem. Tourist activities carried out with Environmental responsibility do not have a positive effect on the biological component of the Pozuzo ecosystem.	-1
H4	The tourist activities carried out with the EMS ISO 14001:2015 have a positive effect on the physical component of the Pozuzo ecosystem. The tourist activities carried out with the EMS ISO 14001:2015 do not have a positive effect on the physical component of the Pozuzo ecosystem.	-0.3
H5	Tourist activities respecting the criteria of the EMS ISO 14001:2015 regulations have a positive effect on the biological component of the ecosystem. Tourist activities respecting the criteria of the EMS ISO 14001:2015 regulations do not have a positive effect on the biological component of the ecosystem.	0.34
H6	The EMS has a positive influence on the protection of the System. The EMS does not have a positive influence on the protection of the System.	0.9

**5.4 Validation**

With the help of the model, the following results were obtained regarding the hypotheses:

H1: The implementation of the EMS has a positive effect on tourist activities. The proposed hypothesis is confirmed with a significant structural coefficient. This is because there is greater awareness among tourists due to the new guidelines offered by tourist companies through ISO14001:2015 certification and training. The hypothesis is validated.

H2: Tourist activities regulated by the EMS reduce the dimension of impacts and subsequently decrease negative effects on the physical aspects of the ecosystem. The proposed hypothesis is confirmed with a significant structural coefficient. This is due to tourist activities led by companies employing protocols from ISO14001:2015 certification and training. The hypothesis is validated

H3: Tourist activities carried out with environmental responsibility have a positive effect on the biological component of the Pozuzo ecosystem. The proposed hypothesis is not confirmed, as it presents a non-significant structural coefficient. Therefore, tourist activities carried out with environmental responsibility do not have a positive effect on the biological component of the Pozuzo ecosystem. This is because tourist companies are not responsible for the behavior of other activities taking place in Pozuzo outside of the tourism sector. The hypothesis is not validated.

H4: Tourist activities carried out with ISO 14001:2015 EMS have a positive effect on the physical component of the Pozuzo ecosystem. The proposed hypothesis is not confirmed with a significant structural coefficient. This is because tourist activities carried out with ISO 14001:2015 EMS do not have a positive effect on the physical component of the Pozuzo ecosystem. This is understood as tourist companies not intervening in the behavior of other activities taking place in Pozuzo outside of tourism. The hypothesis is not validated.

H5: Tourist activities respecting the criteria of the ISO 14001:2015 EMS have a positive effect on the biological component of the ecosystem. The proposed hypothesis is confirmed with a significant structural coefficient. Even though tourist companies do not encompass the total impact received by the biological component of the ecosystem, they partially contribute with a positive effect. The hypothesis is validated.

H6: The EMS has a positive influence on ecosystem protection. The proposed hypothesis is confirmed with a significant structural coefficient. Therefore, companies implementing an EMS instill ecosystem protection in tourists, generating a positive influence on ecosystem protection. The hypothesis is validated.

In summary, the study highlights the importance of EMS implementation and its benefits for tourist activities and, in turn, for the ecosystems in Pozuzo. Moreover, it is evident that after implementation, environmental impacts decrease, contributing positively to the ecosystem."

## **6. Conclusion**

According to the state of the art, it was confirmed that formulating a mathematical model for the tourism sector contributes to the sustainable management of the ecosystem. For the initial diagnosis of the ecosystem, aiming to quantify the positive and negative impacts of tourist activities, the Leopold Matrix was used, resulting in a negative impact of -925. Data was collected through surveys involving a total of 221 individuals, and these data were validated using Cronbach's Alpha, yielding a result of 0.848, indicating the validity of the collected data.

Furthermore, the mathematical model for the ecosystem (Pozuzo) was formulated and developed using structural equations. Seven constructs relevant to the subject matter were established and closely related. The mathematical model was developed through SPSS AMOS software, allowing for the analysis of patterns with a particular focus on EMS implementation. Validation of the mathematical model was achieved through engineering tools implemented in the research work.

To validate sectorial solution proposals and assess the economic viability of the project, it was concluded that the revenues generated by tourist enterprises could fund an environmental management system. The performance of impacts post-EMS implementation was obtained through a second Leopold Matrix. The result of Hypothesis 6 is highlighted, suggesting that EMS has a highly positive influence on ecosystem protection, with a very high coefficient value of 0.9. Finally, through a second Leopold Matrix, environmental impacts caused by tourist activities were weighed, revealing a reduction compared to the initial situation, yielding a final value of -507. This demonstrates the effective performance of the Environmental Management System in the case study.

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