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Perception of the implementation of the environmental management system in universities: A case study in a public university

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Abstract

The environmental management system (EMS) is a structured framework that entities use to manage environmental impacts, ensure compliance with regulations, and incorporate sustainability initiatives. For this reason, the study aims to identify the level of perception regarding implementing the EMS in universities. For this purpose, a study with a mixed approach has been carried out, in a sample composed of 321 students, 114 teachers, 190 administrators, 33 researchers, and 5 university authorities. The results show that the perception of the level of implementation of the EMS is at a medium level, evidencing weaknesses in institutional, pedagogical, investigative, and social responsibility management. This situation shows the lack of training activities, awareness campaigns, and educational programs that allow the adequate development of environmental skills and culture in all university community members. The lack of participation and involvement in institutional environmental management could seriously harm the effectiveness of the university's EMS, which would compromise the fulfillment of its environmental objectives and goals, as well as its commitment to sustainable development and environmental protection.

Keywords: Environmental management, Environmental impacts, Sustainability, Policies, Environmental system

1. Introduction

Humanity's actions and activities have increasingly damaged the environment [1]. The increase in human population, manifested in urbanization [2] and the associated technological advances [3], as well as the use of environmental resources [4], [5], have proven problematic over time [4]. Meeting the human population's basic and development needs involves putting pressure on the environment to meet the growing demands of an ever-expanding society [6]. Technological inventions that exploit natural resources can cause imbalances within ecosystems and reduce natural biodiversity [7]. Agriculture can degrade natural vegetation [8], and excessive water extraction for irrigation and compaction by heavy vehicles and animals have cumulative effects that can

be disastrous for countries whose economies depend heavily on agriculture [9]. The timber industry can cause deforestation [10].

Environmental pollution is also one of the important adverse impacts of human activities, as manifested mainly in the increasing production of waste [11]. Aquatic ecosystems are polluted by discharges of agricultural chemicals and industrial waste leading to a loss of biodiversity [12], [13], and extinction becomes a consequence of the inability of species to adapt to changes in their environment [14]. However, until recent decades, much of the waste was disposed of without real concern for damage to the ecosystem [15]. In addition, the increasing emission of greenhouse gases into the Earth's atmosphere contributes to global warming [16]. Thus, the international community is increasingly aware of the dangers facing the environment due to human activity, which can endanger the survival of the Earth and future generations if not controlled [17]. For this reason, the concept of sustainable development has emerged, through the implementation of environmental management systems (EMS).

One of the latent challenges for countries and their institutions is to implement or apply policies and regulations aimed at the creation of an EMS that proposes a simple structure for the generation and management of the environment, managing, and developing activities with an ecological focus, generating a positive impact at a social and economic level [18]. Among the main difficulties that entities have in developing adequate environmental management, we find the lack of implementation and/or execution of environmental programs and policies, the lack of participation of senior management and its employees in environmental activities (being a difficulty, given that they do not carry out adequate monitoring), the lack of strategies that help care for the environment and the lack of dissemination that promotes the participation of members of the entities in environmental activities [19].

In Latin America, several countries create ministries or specific agencies for environmental management. Thus, the Peruvian state created the National Environmental Council (CONAM) at the end of 1994 as an entity in charge of environmental management at a national level. Peru began regulating the environmental legal framework in the nineties due to the impact that the Rio de Janeiro Summit had in 1992 at a global level and the different agreements signed between countries. In 2008, the Ministry of the Environment (MINAM) was founded, and CONAM merged with it. One of the functions of the ministry is to direct the National Environmental Management System (SNGA), defining it as a set of policies, principles, standards, processes, techniques, and tools that are in charge of organizing the environmental responsibilities and capacities of public entities, allowing the implementation of the National Environmental Policy, taking into account the procedures related to the management of biological diversity, climate change, soil management, among others [20].

The first National Environmental Policy was approved by Supreme Decree No. 012-2009-MINAM, whose general objective is to generate a better quality of life for the population, which allows for ensuring healthy, feasible, and practical environments in the long term; allowing sustainable development of the country, through actions that prevent, protect and recover the environment and its resources, respecting the rights of people [21]. In 2020, the Ministry of the Environment saw the need to update the National Environmental Policy through a broad review process by different organizations by the law, in a participatory and decentralized manner, after a validation and public consultation procedure in July 2021, the new National Environmental Policy to 2030 is approved by Supreme Decree No. 023-2021-MINAM, which has 9 main objectives incorporating guidelines by the new provisions, updating environmental priorities. It took as a reference the current context we have to face public problems about the "decrease in goods and services provided by ecosystems that affect the development of people and environmental sustainability", thus allowing to ensure the well-being of the population.

In 2012, with DS 017-2012-ED, the National Environmental Education Policy of the Ministry of Education was approved, developed on the following: the guidelines on environmental education, culture, and citizenship; Law 28044, General Education Law, has environmental awareness as one of its principles; Law 28611, General Environmental Law, in its article 127 mentions that the National Environmental Education Policy must be compulsory for processes related to education and on other international norms, programs and instruments

aligned to promote both environmental education and culture. It is aimed at forming citizens responsible for caring for the environment, consequently generating a sustainable, competitive, inclusive and identity-driven Peruvian population.

The Ministry of Education recognizes the need to form a new type of citizen, more conscious in their lifestyle about the environment; it is necessary to modify human behavior in favor of sustainable development. Therefore, environmental education has a fundamental role. Environmental education is not only an ethical and theoretical approach but also an operational management strategy for the entire educational process. The policy sets out the guidelines for the development of environmental education in basic and technical-productive education, university and non-university higher education, and environmental community education. Higher education, establishes the development of the environmental approach in professional training, research, social projection, and institutional management [22].

At the higher university level, in Law 30220, the University Law, the environmental issue immersed in University Social Responsibility (USR), Chapter XIII, Article 124, defines USR as the ethical and effective management of the impact generated by the University in society, including the management of the impact produced by the relationships between members of the university community on the environment [23].

At the local level, the Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas (UNTRM) has established its Environmental Policy, a regulatory framework on environmental matters based on the National Environmental Education Policy, approved by the Rectoral Resolution N° 352-2017-UNTRM/R. It sets guidelines to ensure the correct integration of ethical, social, and environmental criteria in the development of the organization's actions. These criteria are framed within institutional management, professional training, scientific research, and social projection. Together they seek to promote the continued participation of the university community and the private sector in the sustainable development of communities, developing plans and projects that contribute to environmental education, recovery, and appreciation of good environmental practices [24].

Based on the above, the objective of the study is to identify the level of perception regarding the implementation of the EMS in universities, through the application of the study at the Toribio Rodríguez de Mendoza National University in Amazonas; to evaluate the effectiveness and impact of the current EMS, identifying strengths, weaknesses and opportunities for improvement; to optimize sustainability practices, promote greater environmental awareness in the university community; contribute to the development of more effective environmental policies in the unique context of the Amazonas region.

1.1. Theoretical framework

An environmental management system (EMS) is a structured framework entity used to manage environmental impacts, ensuring compliance with regulations and incorporating sustainability initiatives beyond mere compliance [25], [26], [27]. Functioning as an information system, an EMS relies on the flow of information and interconnected processes to effectively manage environmental aspects [28], [29]. Implementing an EMS is crucial for organizations, especially small and medium-sized enterprises, to align their activities with environmental requirements amidst a growing demand for environmentally conscious products and services [30], [31]. In addition, advances in technology have led to the development of environmental monitoring management systems, improving the monitoring, management, and maintenance of environmental equipment through real-time data acquisition and big data storage [32]. As environmental laws evolve, the need for systematized environmental management such as EMS becomes increasingly vital to ensure compliance and successful environmental management [33].

Environmental management system indicators play a crucial role in assessing and monitoring environmental impacts and sustainability [29], [34], [35]. These indicators assist organizations in decision-making processes by providing concise and relevant information for effective environmental management [36]. While traditional approaches focused on financial performance, the shift toward environmental compliance has highlighted the

importance of measuring environmental performance through indicators [37]. The development and use of biocultural indicators, rooted in local values and relationships between nature and people, are increasingly recognized as essential to achieving ecological and social sustainability in environmental management projects [38].

Various studies have highlighted the importance of indicators such as the Industrial Solid Waste Free Disposal Index in the evaluation and management of environmental problems in Latin American industries [39], [40]. Additionally, the development of environmental management indicators at the municipal level has been proposed in countries such as Colombia to promote sustainable development and adequate environmental management [41]. Comparative analyses of public policies in Latin American countries have emphasized the importance of indicators related to multilateral agreements [42], environmental policy frameworks, and the level of responsibility of governing bodies in achieving successful results in environmental management [43]. These indicators not only help to assess the current state of the environment but also help to identify responsible actors and areas for improvement in environmental management practices [44].

The concept of sustainable development, defined in the Brundtland Report as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [45], has been widely adopted by higher education institutions. According to Lozano et al. [46], universities play a crucial role in transforming societies towards sustainability, not only through education and research but also through their operations and their influence in the community. This aligns directly with Sustainable Development Goal - SDG 4 (Quality Education), in particular, target 4.7[1], which seeks to ensure that all students acquire the theoretical and practical knowledge necessary to promote sustainable development [47].

EMS is an essential tool for organizations seeking to improve their environmental performance. According to ISO 14001, an EMS is part of an organization's management system, used to develop and implement its environmental policy and manage its environmental aspects [48]. In the university context, Clarke & Kouri [49] point out that the implementation of EMS in higher education institutions not only improves their environmental performance but also contributes to the training of environmentally conscious professionals. This approach is closely linked to SDG 12 (Responsible Production and Consumption), which promotes sustainable production and consumption patterns.

The concept of university environmental responsibility is derived from the broader notion of university social responsibility. Vallaeys [50] defines the latter as a policy of continuous improvement of the university towards the effective fulfillment of its social mission through four processes: ethical and environmental management of the institution; training of responsible and supportive citizens; production and dissemination of socially relevant knowledge; social participation in promoting more humane and sustainable development. This perspective is aligned with SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action), which address urban sustainability and climate action respectively.

Environmental perception plays a crucial role in the effective implementation of EMS in universities. Ajzen [51] proposed the theory of planned behavior, which suggests that attitudes toward behavior, subjective norms, and perceived behavioral control together shape an individual's intentions and behaviors. In the university context, Zsóka et al. [52] found that intensive environmental education in higher education has a positive impact on students' environmental awareness and their reported consumption patterns. These studies relate to SDG 17 (Partnership for the Goals), which emphasizes the importance of partnerships and multi-stakeholder engagement to achieve sustainable development goals.

Measuring environmental performance in universities is crucial for continuous improvement. Lauder et al. [53] state that sustainability indicators provide a means to measure progress toward sustainability goals and to

[1]By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, inter alia, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development.

communicate this progress to stakeholders. One widely used tool is the UI Green Metric World University Ranking, which assesses and compares the sustainability efforts of universities around the world [54]. These efforts are aligned with SDG 9 (Industry, Innovation, and Infrastructure), which promotes innovation and the adoption of clean technologies.

Effective implementation of EMS requires a robust governance framework. According to Disterheft et al. [55], participation is a key factor for the success of sustainability initiatives in higher education. Furthermore, Leal et al. [56] argue that clear institutional policies and senior management support are critical to the successful integration of sustainability in universities. These governance aspects relate to SDG 16 (Peace, Justice, and Strong Institutions), which calls for effective, accountable, and inclusive institutions.

The research is crucial because it can significantly improve sustainability practices in higher education. This study has the potential to identify barriers and solutions to the effective implementation of environmental policies, inform better governance strategies, influence green behaviors, and contribute to the Sustainable Development Goals. Furthermore, it can help universities lead the change towards a more sustainable society, improving their environmental impact and training more environmentally conscious professionals.

2. Research method

Provide sufficient detail to allow the work to be reproduced. Methods already published should be indicated by a reference: only relevant modifications should be described.

2.1. Studio location

This research was carried out at the Campus of the Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas (UNTRM), which is located in the city of Chachapoyas, in the department of Amazonas, situated in the northeast of the country. It is bordered to the north by Ecuador; to the east by Loreto; to the southeast by San Martín; to the south by La Libertad; and to the west by Cajamarca. Its coordinates are 2º 59' south latitude and between the meridians 77º 9' and 78º 42' west longitude.

The province of Chachapoyas is located on the right bank of the Utcubamba valley, bordered to the north by the Province of Luya and Bongará; to the east by the Province of Rodríguez de Mendoza and the Department of San Martín; to the south by the Department of San Martín; and to the west by Cajamarca. The city of Chachapoyas is located at 2,335 meters above sea level, bordered to the north by the district of Huancas and the district of Sonche, to the east by the district of San Francisco de Daguas, to the south by the district of Soloco and the district of Levanto and to the west by the province of Luya.

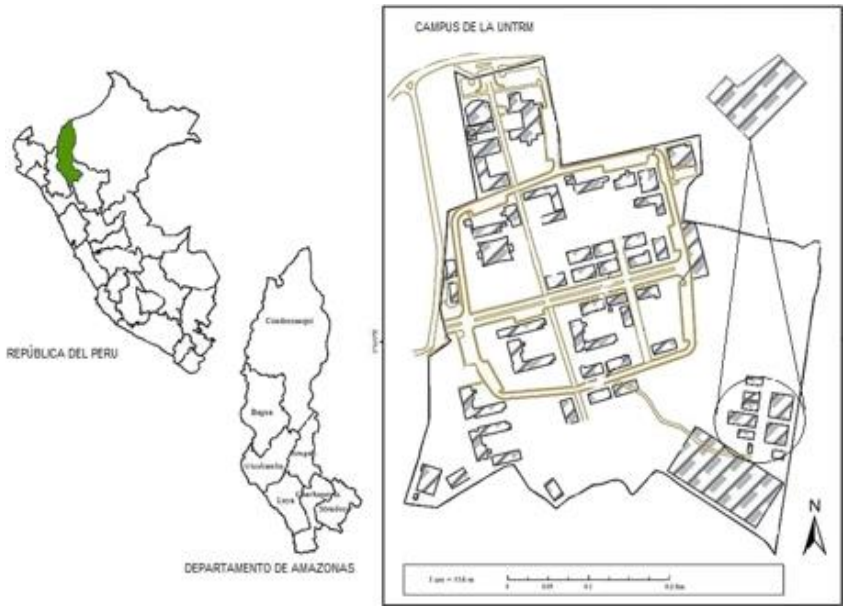

Figure 1. Study location map

2.2. Type and design of the study

The research was basic because it pursues pure purposes aimed at strengthening the scientific theoretical context of the object of study; it also has a mixed approach (quantitative and qualitative), with a non-experimental design; due to the lack of deliberation of the variables studied, trying to describe their particularities and characteristics in a real and natural context. To identify the perception of the different actors in environmental management at UNTRM.

2.3. Population

The study population consisted of 3,983 students (2022-I), 323 teachers, 759 administrators, 33 university researchers and 25 authorities.

2.4. Sample

A simple probabilistic random sampling was used to obtain a sample corresponding to students, teachers, and administrators, according to the formula:

$$n = \frac{Z_\alpha^2 * p * q * N}{e^2(N-1) + Z_\alpha^2 * p * q}$$

Where:
N: Population (3983 students, 23 teachers, 759 administrators)
n: Desired sample size
z: Confidence Level (95%)
e: Maximum accepted estimation error (5%)
p: Probability of the studied event occurring (success) (50%)
q: (1 – P) = Probability that the event studied does not occur

The sample obtained was 350 students, 176 teachers and 255 administrators. However, it was found that the sample size was greater than 5% of the population size (fc = n/N > 5%), therefore, the correction factor formula was applied:

$$n = \frac{n}{1 + \frac{n}{N}}$$

The final sample was made up of 321 students, 114 teachers, and 190 administrators.

On the other hand, for the group of researchers, convenience sampling was applied to the entire population made up of 33 researchers and 5 authorities who wished to participate in the study.

2.5. Data collection and analysis technique

The questionnaire was structured according to the study variables and consists of 18 items related to the environmental management system, distributed in 4 dimensions: 7 items for the institutional and organizational management dimension, 5 items for pedagogical management, 3 items for the research dimension, and 3 items for the social responsibility dimension. While the sustainable development variable was structured based on 12 items; the first 3 items corresponded to the economic growth dimension, the following 5 questions focused on the environmental care dimension, and finally, the social well-being dimension, which had 3 items.

Reliability was demonstrated by applying Cronbach's alpha, resulting in a high level of reliability of 0.97 for both variables. It was also validated by 4 expert opinions, specializing in environmental management and environmental policies with more than 5 years of professional experience in environmental management in different sectors.

The survey was applied virtually through Google Forms, which was sent through the institutional e-mails of students, teachers, and administrative staff from April to June, by the Information Technology Office of the university. In the case of administrative personnel who did not have institutional mail, physical surveys were

conducted. This strategy made it possible to complete the application of surveys to the entire sample selected for the study.

In the case of the authorities, a semi-structured interview was conducted for convenience with 5 UNTRM authorities, who were coded as follows: Head of the Infrastructure and Environmental Management Unit (A1), Head of the Budget and Planning Office (A2), Director of Academic Quality Management (A3), Director of the Research Institute for Sustainable Development of Ceja de Selva - INDES-CES (A4) and Director of the Research Institute in Agribusiness - INNA (A5). This interview consisted of 24 questions focused on the environmental management of UNTRM, 10 about Institutional Management, 4 related to Professional Training, 4 about Scientific Research, 3 corresponding to Social Projection, and 3 about Economic Impact. Before conducting the interview, the informed consent to participate in the study according to the scope of the objectives and not to disclose their data was signed. The interview lasted an average of one hour, which allowed for detailed data collection.

Data analysis was performed using SPSS v26, for quantitative data using descriptive statistics which allowed identifying the level of perception of the different interest groups. A barometer was used to convert the 5-point Likert scale to a three-level scale (low, medium, and high). This analysis made it possible to identify the perceptions of environmental management of the different groups that participated in the study. For the qualitative analysis, the method of reflective thematic analysis was used, according to Braun et al. [57] they propose a method of reflective thematic analysis that integrates narrative interpretation, highlighting the importance of the researcher's reflexivity in the process.

3. Results

3.1. Student perception

The level of implementation of the environmental management system of the Toribio Rodriguez de Mendoza National University of Amazonas according to the students was average at 91%, as well in the dimension of institutional and organizational management at 69%, pedagogical management at 76%, research management with 62%, and social responsibility with 58%. In addition, it should be noted that the students consider that the Toribio Rodriguez de Mendoza National University of Amazonas does have an environmental management system implemented with 70% acceptance, and those who consider that it does not, make up 30%, which is considerably better. The students did not know in 61% that the "Infrastructure and Environment Directorate" is responsible for the environmental management system of the Toribio Rodriguez de Mendoza National University of Amazonas and those who did know are within the 39% range. 90% of students do not participate in any activity focused on the environmental management system of the Toribio Rodríguez de Mendoza National University of Amazonas and only 10% indicated their participation.

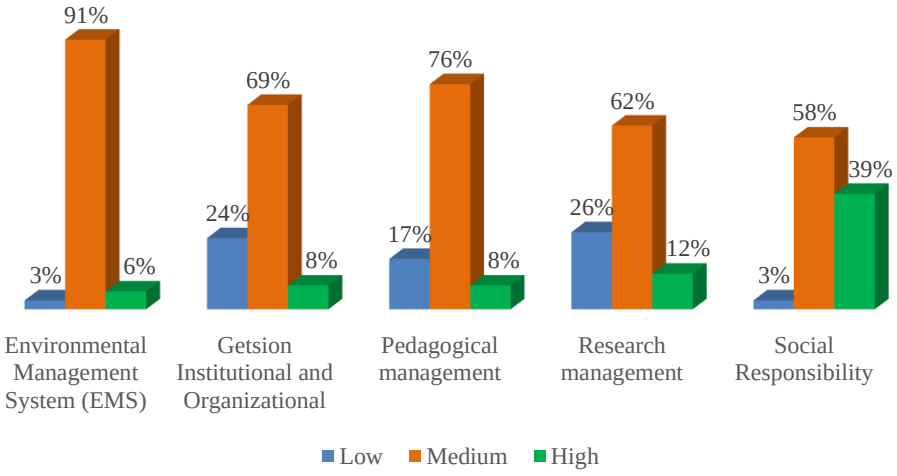

Figure 2. Students' perception regarding the level of implementation of the environmental management system

3.2. Teachers' perception

The level of implementation of the environmental management system of the National University Toribio Rodriguez de Mendoza de Amazonas, according to the teachers, is medium to a greater extent with 77%, as well as in the dimensions of institutional and organizational management with 56%, pedagogical management with 59%, and social responsibility with 71%. In addition, it is evident that according to the professors the level of research management in the entity is low to medium with 50% and 46% respectively. In that same sense, 63% of the teachers consider that the National University Toribio Rodriguez de Mendoza de Amazonas does not have an environmental management system implemented and only 37% said that it does. Also, 65% of the teachers did not know that the "Infrastructure and Environment Department" is responsible for the environmental management system of the National University Toribio Rodriguez de Mendoza de Amazonas and only 35% did. 83% of teachers do not participate in any activity focused on the environmental management system of the Toribio Rodríguez de Mendoza National University of Amazonas and 17% responded positively.

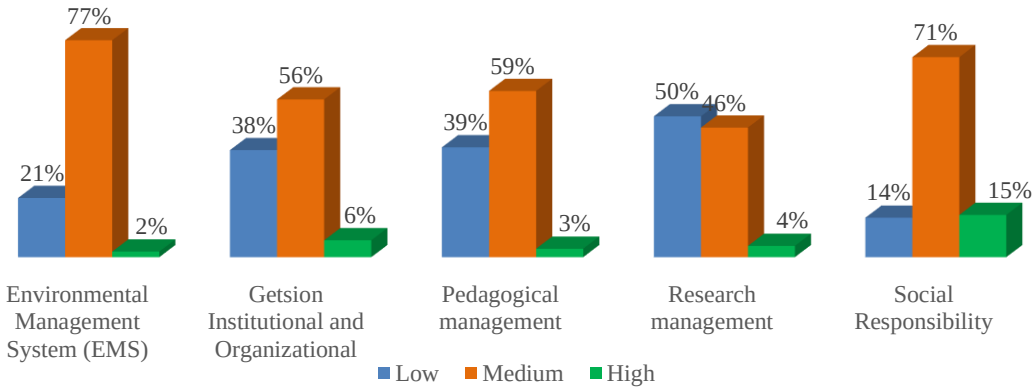

Figure 3. Teachers' perception regarding the level of implementation of the environmental management system

3.3. Perception of administrative staff

The level of implementation of the environmental management system of the Toribio Rodríguez de Mendoza National University of Amazonas according to the administrative staff was medium to a greater extent with 85%, as well as in all its dimensions, being represented in institutional and organizational management with 61%, pedagogical management 77%, research management 65% and social responsibility with 51%. Likewise, for 66% of the administrative staff, the Toribio Rodríguez de Mendoza National University of Amazonas has an environmental management system implemented, and for 34% it does not have one. On the other hand, 62% of the administrative staff knew that the "Infrastructure and Environment Directorate" is responsible for the environmental management system of the Toribio Rodríguez de Mendoza National University of Amazonas and only 38% had no knowledge about it. 83% of the administrative staff do not participate in any activity focused on the environmental management system of the Toribio Rodríguez de Mendoza National University of Amazonas, and to a lesser extent, only 17% participate.

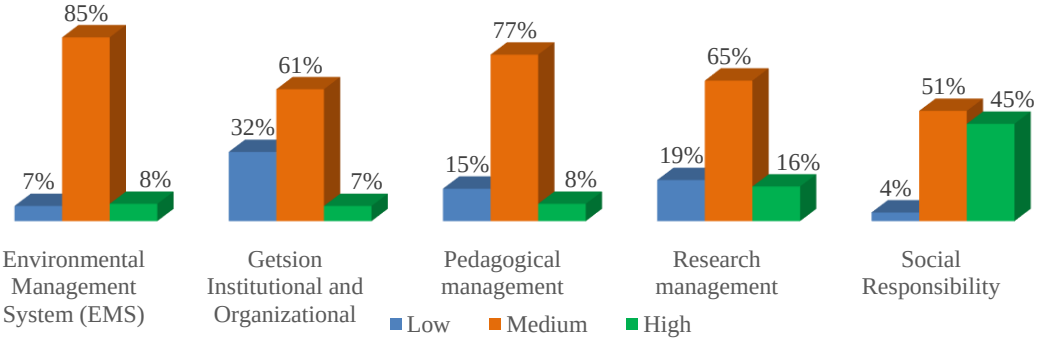

Figure 4. Perception of administrators regarding the level of implementation of the environmental management system

3.4. Researchers' perception

The level of implementation of the environmental management system of the National University Toribio Rodriguez de Mendoza de Amazonas, according to the researchers, is medium-high at 76%, as well as in its dimensions of institutional and organizational management 61%, pedagogical management 70%, research management with 55% and social responsibility 61%. Likewise, 79% of the researchers consider that the National University Toribio Rodriguez de Mendoza de Amazonas does not have an environmental management system implemented, while 21% stated that it does. In addition, 79% of the researchers knew that the "Infrastructure and Environment Directorate" is responsible for the environmental management system of the National University Toribio Rodriguez de Mendoza de Amazonas and only 21% were unaware. Finally, the researchers as a whole do not participate in any activity focused on the environmental management system of the National University Toribio Rodriguez de Mendoza de Amazonas.

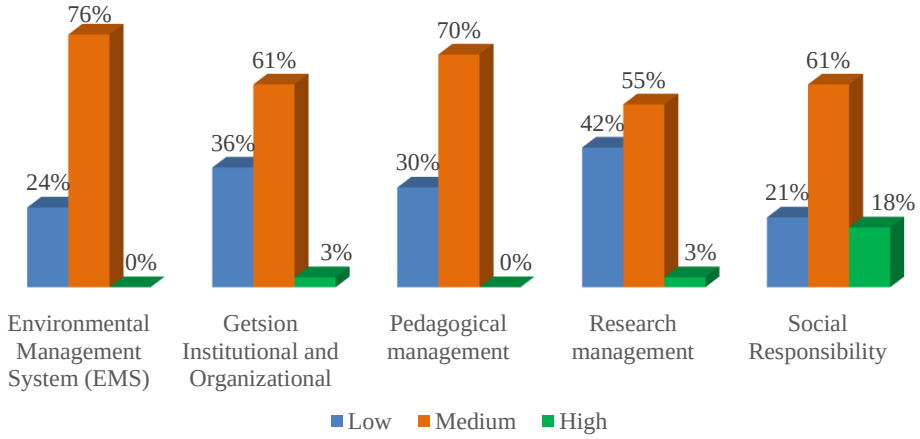

Figure 5. Researchers' perception regarding the level of implementation of the environmental management system

3.5. Perception of the 4 groups surveyed on the SGA at UNTRM

The implementation of the environmental management system at the Toribio Rodríguez de Mendoza National University in Amazonas reflected a medium level, with 77%, with students and administrators having the greatest impact on these results, 91% and 85% respectively. These results show that the level of implementation according to the perception of individuals is medium, regardless of the type of position within the university community.

Table 1. Contingency table of the types of participants and the level of implementation of the environmental management system

Type of participant		SGA level			Total
		Low	Half	High	
Administrative	Count	13	161	16	190
	% of total	7%	85%	8%	100%
Students	Count	10	291	20	321
	% of total	3%	91%	6%	100%
Researchers	Count	8	25	0	33
	% of total	24%	76%	0%	100%
Teachers	Count	24	88	2	114
	% of total	21%	77%	2%	100%

3.6. Perception of UNTRM authorities regarding the level of implementation of the environmental management system

3.6.1. Institutional management

Most authorities consider that there is an environmental management policy. However, they also mention that it is lacking implementation mainly due to a lack of budget. They also highlight the work that has been carried out about the environment. For example, there is an electrical system and 80% of consumption is covered by renewable energies from UNTRM, the installation of smart pipes, and water harvesting systems to save drinking water. They also mention that the environmental management instruments at UNTRM are the collection of hazardous solid waste and the organization of eco-efficiency committees.

….UNTRM does have a policy. The implementation [...] has been limited by budget…. (A1)

...The document exists, but no resources have been deployed for its implementation… (A2)

…Yes, the university has an environmental policy, but I believe that it is not fully implemented… (A4)

…In environmental management, eco-efficiency is the most worked on…(A3). Eco-efficiency initiatives have been developed [...] eco-efficiency committees have been formed... (A5)

An important aspect to highlight is how the majority do not know whether UNTRM has an environmental management plan, and they also consider that they do not have an EMS implemented. There is also no budget to implement actions within the framework of environmental policy within the institutional operational plan for the year. Despite this, it was mentioned how through research projects or areas of UNTRM they carry out activities aligned with environmental management. For example, the renewable energy project.

…The Environmental Management Plan was valid from 2016 to 2021 [...] It is currently in the process of being updated... (A1)

…No. Perhaps it has not been disseminated, in any case, each institute has its management plan that also considers the environmental issue…. (A4)

…No, a management system requires resources, and participation of the entire community [...] and that has not been developed yet… (A3)

…No, UNTRM does not yet have an SGA implemented…. (A5)

……A specific budget has not been allocated. The financial resources are scarce. A project should perhaps be generated…. (A1, A3, A5)

UNTRM has a solid waste management plan, which is taken to a landfill and hazardous waste to the regional hospital. This institution also has inter-institutional agreements with the Universities of Colombia, Sao Paulo-Brazil, Italy, and Mexico that organize activities within the framework of sustainability.

.....Yes, UNTRM complies with solid waste management, hazardous waste is managed through the company TUNKI.. (A1)

.....It has just been updated this year. I have not reviewed those changes. In any case, compliance with the regulations is being achieved….. (A3)

.....We have several agreements with other universities at an international level, I don't know if exactly to look at the environmental issue…(A2)

....Through the institute we have agreements with the: Universities of Colombia, Sao Paulo-Brazil, Italy, and Mexico…. (A5)

3.6.2. Vocational training

UNTRM contributes to the training of students in environmental management. In the case of students in the professional career of animal husbandry, there is a course on "Ecological Waste Processes" where all waste generated is used. In addition, there are social projects to strengthen the environmental commitment of the university community as the curriculum allows.

…..Yes, it is one of the priorities. The curriculum has been modified, and the aim is to integrate courses according to the careers that have to do with and guide with the environmental issue… (A1)

….The market requires professionals who are focused on social and environmental changes… (A2)

...Some courses encourage student participation in environmental projects more than others; awareness is still lacking. (A3)

… Some think that environmental skills are already present in graduate profiles, while others consider that the real impact still needs to be measured and the curriculum in all courses needs to be updated to ensure that graduates acquire these skills… (A1, A2, A3, A4, A5)

3.6.3. Scientific research

UNTRM has research groups that promote scientific research on environmental issues and environmental sustainability. Its most important representative is the Institute for Sustainable Development Research - Ceja de Selva (INDES-CES), with the participation of the vice-rectorate of research and research circles. UNTRM has developed environmental guidelines that are considered in the research regulations.

…Research is highly promoted, as are various related events, including those linked to environmental issues.… (A2)

….The research regulations encourage this type of research... (A5)

3.6.4. Social projection

UNTRM has programs or projects with the private sector on social responsibility for the environment in two ways: Social extension programs (training in neighborhoods, and educational institutions) and Technical Guidance: To companies, municipalities, and organizations through specific framework agreements.

The improvement in the environmental commitment of the population has been evidenced by the events carried out by the university through INDES-CES. A clear example is the reforestation program worked on in collaboration with the different municipalities. Likewise, they report that the associations have a great interest in the training they provide.

….The purpose of the university is education. Social outreach programs and technical guidance for companies and organizations are managed…We work with private and public institutions through agreements. We participate in different projects or competitive funds… (A1)

…..The level of participation is defined by each race. We support associations, municipalities, and regional government, and transfer knowledge…. (A4)

⋯ some agreements have been signed in the region and outside, mostly to develop business plans with the public sector and producer associations… (A5)

3.6.5. Economic impact

The university has never received a financial incentive for its practices in environmental care. Most people believe that UNTRM's intervention in environmental matters has produced significant economic growth for the families of the community. For example: livestock farming transfers knowledge for management with an environmental focus and also improves the breed, which brings improvements to the community's income.

…No financial recognition has been received on environmental issues… (A1, A2, A5)

….The university shows its impact more internally. Although work is being done on the issue, it is not very relevant to the external community… (A2)

….It has contributed. Many areas and producers have benefited from the activities we carry out, especially in environmental matters…. (A4)

…..An example would be livestock farming, where knowledge about environmentally-focused management is transferred, which has improved the breed of animals and, therefore, the income of the community… (A5)

4. Discussion

The main finding that the general perception of the implementation of the SGA at UNTRM is medium (77% on average) among all groups surveyed (students, teachers, administrators, and researchers) suggests that, although efforts have been made in this direction, there is still room for improvement. This result is in line with what was proposed by Lozano et al. [46] who emphasize the crucial role of universities in the transformation of societies towards sustainability. However, it also indicates that UNTRM has not yet reached its full potential in this regard. The average level of perception could be explained by what Vallaeys [50] describes as the need for a policy of continuous improvement of the university toward the effective fulfillment of its social mission. The results suggest that UNTRM is in the process of implementing this policy, but has not yet achieved full integration into all aspects of its operation.

Studies have shown that managers exhibit high levels of environmental awareness in terms of attitude, while knowledge and behavioral awareness are moderate [58]. Lack of environmental awareness is often attributed to insufficient information, leading to a lack of participation in environmental practices [59]. Universities play a crucial role in promoting environmental sustainability, with a study by the Indian Institute of Technology Roorkee highlighting the importance of environmental factors in management and educational aspects [60]. Furthermore, research on teachers' perceptions and actions toward environmental management emphasizes the positive relationship between teachers' perceptions and students' actions in environmental management [61]. These findings collectively suggest a varied level of environmental awareness among different stakeholders, emphasizing the importance of promoting environmental awareness across multiple sectors.

Notably, there are differences in perception between the different groups surveyed. For example, students and administrators have a more positive perception (91% and 85% respectively consider the level to be average) compared to teachers and researchers. These disparities could be explained through the theory of planned behavior of Ajzen [51], which suggests that attitudes, subjective norms, and perceived behavioral control influence intentions and behaviors. Differences in exposure to and level of participation in environmental initiatives may be influencing these divergent perceptions.

Studies have highlighted the importance of environmental management in universities. Research has shown that universities play a crucial role in promoting sustainability through education and practical applications [60], [62], [63]. These studies have evaluated universities on a variety of criteria, including green management practices, stakeholder engagement, and sustainability activities such as energy, transportation, waste management, and research applications. The results indicate that while universities in different regions display different levels of environmental management, there is a growing emphasis on becoming greener and more sustainable. The research emphasizes the need for universities to prioritize environmental variables such as water management, waste, and infrastructure management to improve their overall sustainability performance [64].

Research on the perception of environmental management in universities has shown that higher education institutions are actively participating in promoting environmental sustainability [65]. The studies have focused on evaluating the capacity of universities to promote environmental awareness among students and researchers, highlighting the importance of policies related to waste management and green transport [66]. Furthermore, research has looked at students' environmental attitudes and knowledge, emphasizing the need for more

intensive environmental education programs at universities to raise awareness and encourage proactive actions [67]. Furthermore, studies have explored students' perceptions of environmental education (EE) activities, indicating the importance of EE as an awareness-raising tool and the need to adopt activities that contribute to a more critical and emancipatory approach to environmental education [68].

The average level is due, to a large extent, to the fact that in many cases students, administrative staff, teachers, and researchers are unaware of and do not participate in environmental management, evidencing the lack of implementation of activities that develop environmental skills and culture in the members of UNTRM, which could harm its environmental management system. There are limitations to the implementation of environmental management in universities, which include lack of funding, stakeholder participation, human resources, senior management leadership, complex real estate, conflicting priorities, and energy-intensive research [69], [70]. Higher education institutions face unique challenges in adopting formal environmental management systems (EMS) such as ISO 14001 [71], with key barriers including lack of management commitment, financial resources, expertise, organizational issues, and insufficient engagement of students, staff, and faculty [72], [73], [74]. The environmental performance of universities is hampered by problems such as inadequate waste management, high energy consumption, pollution, and unsustainable practices [75], [76]. Combining sustainable development principles with effective management practices is crucial to creating a sustainable university environment [77].

The results indicate a low level of knowledge and participation in SGA activities among all groups. This aligns with the findings of Zsóka et al. [52] who emphasize the importance of intensive environmental education in higher education to improve environmental awareness. The lack of participation and knowledge suggests that UNTRM could benefit from greater integration of environmental education in its programs, as proposed in SDG 4, specifically target 4.7.

The average perception in the institutional and organizational management dimension (69% for students, 56% for teachers, 61% for administrators) suggests that, although there are policies and structures for the SGA, its implementation and visibility could be improved. This is related to what was raised by Clarke & Kouri [49] on the importance of implementing EMS in higher education institutions not only to improve environmental performance but also to contribute to the training of environmentally conscious professionals.

The average level of perception in the dimensions of pedagogical and research management indicates that there are opportunities to improve the integration of environmental issues in teaching and research. This aligns with the concept of the university social responsibility of Vallaeys [50], which includes the production and dissemination of socially relevant knowledge. UNTRM could consider strengthening these aspects to better fulfill its role in promoting sustainable development.

The social responsibility dimension is also perceived at a medium level, suggesting that UNTRM is making efforts in this area, but can still improve its impact on the community. This relates to SDG 17 (Partnerships to achieve the goals) and the importance of collaborations to achieve sustainable development goals.

Interviews with authorities reveal barriers to effective implementation of the SGA, such as lack of budget and the need for greater dissemination and participation. These challenges are consistent with those identified by Lauder et al. [53] and Disterheft et al. [55], who highlight the importance of participation and institutional support for the success of sustainability initiatives in higher education. These actions align with what Suwartha & Sari [54] described in the UI GreenMetric World University Ranking, which assesses universities' sustainability efforts. However, the overall mid-level perception suggests that these initiatives may not have the desired impact or may not be effectively communicated to the entire university community.

The inclusion of courses related to environmental management in some courses, such as the course on "Ecological Waste Processes", is a positive step. However, the lack of consensus among authorities on whether environmental skills are present in the graduate profiles of all courses suggests an opportunity for improvement.

This is related to what was raised by Zsóka et al. [52] on the importance of intensive environmental education in higher education to improve students' environmental awareness and behavior.

It is important to acknowledge the limitations of this study to properly contextualize the results and conclusions derived. First, the study is based on perceptions, which may be influenced by subjective factors and may not necessarily accurately reflect the objective reality of SGA implementation. Furthermore, the sample, although diverse, may not be fully representative of the entire university community. Another limitation is the possible lack of detailed knowledge about SGA among some of the respondents, which could have affected their responses. The study was also conducted at a specific point in time, which does not allow for capturing changes or improvements that may have occurred before or after the data collection period.

5. Conclusions

According to the characterization of the UNTRM environmental management system, it was found that the EMS is still in the process of implementation. The university develops actions in favor of the environment, but mechanisms for adequate follow-up, control, or monitoring have not been developed, making it difficult to demonstrate compliance with the commitments declared in the environmental policy; neither are the management documents updated nor is the participation of members of the university community in environmental management promoted. Actions must be fulfilled from a systemic approach; the above-mentioned demonstrates the need for an area dedicated exclusively to environmental management and sustainability.

However, after analyzing the different environmental management systems, it became evident that the EMS within the university framework fulfills a different role than that of an industry organization given its humanistic and social purpose. Universities must focus on the impact caused by members of the university community, mainly on their students and graduates, who must take actions for sustainable development during the performance of their activities, not only academic, and work, but also personal, family, and community. The university EMS must contribute to transform and achieve an environmental culture.

The average level of EMS at the Universidad Nacional Toribio Rodríguez de Mendoza (UNTRM) is largely because in many cases students, administrative staff, teachers and researchers are unaware of and do not actively participate in environmental management, even when it is being implemented at the university. This situation highlights the lack of training activities, awareness campaigns, and educational programs that allow the proper development of environmental skills and culture in all members of the university community. The low participation and involvement in institutional environmental management could seriously harm the effectiveness of UNTRM's EMS, which would compromise the fulfillment of its environmental objectives and goals, as well as its commitment to sustainable development and environmental protection.

The findings underscore the importance of addressing disparities in perception and participation among different groups within the university. Deeper integration of environmental education into academic programs, strengthening research on sustainability issues, and expanding social outreach programs are key areas requiring attention. These actions would not only improve the university's environmental performance but would also significantly contribute to the training of more environmentally conscious professionals, in line with the Sustainable Development Goals, particularly SDG 4 on quality education and SDG 13 on climate action. Furthermore, the perception of a positive economic impact on the local community through UNTRM’s environmental interventions suggests significant potential to scale up and strengthen these initiatives, thereby promoting broader sustainable development in the region.

Going forward, it is recommended that universities develop a comprehensive strategy to address the barriers identified, such as lack of budget and the need for greater outreach and engagement. This could include seeking additional funding sources for sustainability projects, implementing more robust training programs for all staff and students, and establishing more effective mechanisms for communication and monitoring of environmental

initiatives. In addition, the university could benefit from closer collaboration with other higher education institutions and environmental organizations to share best practices and resources. It is crucial to develop training and awareness campaigns that actively involve all members of the university community. These initiatives should include environmental induction programs, hands-on sustainability workshops, a strong communication strategy, and the training of environmental ambassadors. In addition, the integration of sustainability content into the curricula of all disciplines is fundamental to creating an ingrained environmental culture in the institution.

UNTRM must implement a continuous process of evaluation and improvement of its environmental management system (EMS), combining objective metrics with the perceptions of the university community, while adopting broader institutional policies and practices that promote sustainable development. This includes strengthening environmental governance, prioritizing sustainability research, strengthening ties with the local community, optimizing resource management, and developing green infrastructure. These actions will not only improve the university's environmental performance but will also make it a benchmark for sustainability, training environmentally conscious professionals and contributing significantly to the achievement of the Sustainable Development Goals at both the regional and national levels.

Finally, as a case study of a single university, the results may not be generalizable to other higher education institutions, especially those in significantly different contexts. Future studies could address these limitations by including objective measures of environmental performance, conducting longitudinal studies, and comparing them with other universities.

Declaration of competing interest

The authors declare that they have no known financial or non-financial competing interests in any material discussed in this paper.

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Author contribution

Conceptualization, JNAT. and OCC.; methodology, JNAT.; software, OCC; validation, OCC., RCS. and YCMR; formal analysis, JNAT.; investigation, ESB. and AMCR; resources, RCS.; data curation, JNAT.; writing—original draft preparation, YCMR and AMCR.; writing—review and editing, ESB.; visualization, OCC.; supervision, JNAT.; project administration, RCS.; funding acquisition, YCMR. All authors have read and agreed to the published version of the manuscript.

Ethical approval statement

Ethical approval does not apply to this research.

Informed consent

Informed consent for the publication of personal data in this article was obtained from the participant(s).

Declaration of use of AI in the writing process

The authors did not use AI during the preparation of this paper. The authors reviewed and edited the paper to the extent necessary and take full responsibility for the final version.

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