Understanding Waste Management Behavior in Higher Education: A Knowledge, Attitudes and Practices (KAP) Study to Support Sustainable Campus Strategies

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Abstract– ***This study explored the waste management knowledge, attitudes, and practices (KAP) of the community at Escuela Superior Politécnica del Litoral (ESPOL), an Ecuadorian higher education institution, and identified strategies to support campus sustainability. A qualitative KAP approach was adopted through 24 semi-structured interviews with members of the university community. The findings revealed that 62.5% of participants had limited or no knowledge of waste management concepts, while 54% were unfamiliar with waste segregation practices. Despite these knowledge gaps, respondents generally demonstrated positive environmental attitudes and reported several sustainable practices, including the use of reusable water bottles, reusable shopping bags, and voluntary recycling initiatives. However, inadequate knowledge and insufficient waste segregation infrastructure limited the adoption of appropriate waste management practices. Participants consistently highlighted environmental education, clearer waste segregation systems, and improvements in campus infrastructure and institutional processes as the main priorities for strengthening waste management. These findings provide evidence to support the design of sustainable waste management strategies for higher education institutions and contribute to the achievement of institutional and broader sustainability goals.***

Keywords-- ***Solid waste management, Sustainable campus, Higher education institutions, Environmental education, Knowledge-attitude-practice (KAP)***

I. Introduction

Higher education institutions (HEIs) play a fundamental role in advancing sustainable development through education, research, innovation, and community engagement. Beyond their educational mission, universities operate as complex organizations that generate considerable amounts of municipal solid waste through academic, administrative, residential, commercial, and recreational activities. Consequently, HEIs are increasingly expected to implement effective waste management systems while fostering environmental awareness and sustainable behaviours among students, faculty, administrative staff, and visitors. As sustainability becomes a strategic priority worldwide, university campuses have emerged as living laboratories where environmental policies and behavioural change can be translated into practical actions that contribute to the United Nations Sustainable Development Goals (SDGs).

Solid waste management (SWM) remains a significant challenge for higher education institutions, particularly in developing countries where waste management practices often receive limited institutional attention and resources. Previous studies have demonstrated that implementing Integrated Solid Waste Management Plans (ISWMPs) can improve recycling rates and strengthen institutional sustainability. Nevertheless, the success of these initiatives depends not only on waste collection infrastructure but also on the active participation and environmental commitment of the university community.

Recycling facilities, environmental education campaigns, stakeholder engagement, and institutional support have been consistently identified as critical factors for promoting sustainable waste management practices [1], [2]. Likewise, involving campus stakeholders in environmental initiatives significantly enhances the effectiveness of institutional sustainability strategies [3], [4].

Although research on waste management in higher education institutions has expanded considerably in recent years, the existing literature has predominantly addressed technical aspects such as waste characterization, recycling systems, infrastructure, and quantitative assessments of students' environmental behaviour. Recent systematic reviews highlight the need for greater attention to behavioural dimensions and stakeholder participation as essential components of sustainable campus strategies [5], [6].

Furthermore, despite the growing number of studies conducted in Latin America, relatively few have adopted a qualitative approach to examine the knowledge, attitudes, and practices (KAP) of the broader university community—including students, academic staff, administrative personnel, and operational employees—within the same institutional context [7]. This gap limits the understanding of the behavioural factors that influence the success of institutional waste management initiatives and, consequently, the design of evidence-based sustainability strategies.

The Knowledge, Attitudes and Practices (KAP) framework provides a useful behavioural perspective for understanding how individuals perceive waste management, how these perceptions shape their attitudes, and how both influence

environmental practices. Rather than focusing exclusively on technical solutions, the KAP approach recognises that sustainable waste management also depends on behavioural change, environmental awareness, and institutional engagement. Consequently, analysing these three dimensions offers valuable evidence for designing interventions that encourage responsible waste management behaviours and strengthen sustainable campus initiatives. This perspective is particularly relevant in the context of the United Nations Sustainable Development Goals (SDGs), which promote responsible consumption, environmental protection, public health, and sustainable development.

Therefore, this study explores the knowledge, attitudes, and practices related to solid waste management among members of the community of Escuela Superior Politécnica del Litoral (ESPOL), an Ecuadorian higher education institution, through a qualitative interview-based approach.

Based on the experiences and perceptions of students, academic staff, administrative personnel, and operational employees, the study identifies behavioural barriers, existing good practices, and feasible institutional strategies to improve waste management. By providing qualitative evidence from an Ecuadorian university, this research contributes to the growing body of knowledge on sustainability in higher education and demonstrates how behavioural analysis can support evidence-based decision-making for the development of more effective sustainable campus strategies.

II. Literature Review

A. Waste Management

Waste management (WM) practices and processes have evolved considerably over recent decades [8], [9]. Economic development, urbanisation, and population growth have contributed to a substantial increase in waste generation worldwide [10]. Waste management encompasses the collection, transportation, treatment, disposal, and monitoring of discarded materials generated by industrial, commercial, institutional, and community activities [11].

The primary objectives of waste management are to conserve natural resources, protect the environment, and preserve ecosystems for future generations [2], [4]. Additional objectives include maintaining clean public spaces [12], discouraging indiscriminate waste disposal, and reducing environmental pollution affecting streets and communities. Equally important, effective waste management seeks to minimise risks to public health and hygiene. Accordingly, implementing sustainable waste management strategies can increase recycling rates while reducing the environmental impacts associated with inadequate disposal systems.

Sustainable solid waste management solutions should be designed according to the specific characteristics and needs of each context. Nevertheless, successful implementation remains challenging, particularly in developing countries, where limited technical knowledge, insufficient community participation, and institutional constraints frequently hinder the achievement of waste management objectives [13], [14].

Developing and implementing an Integrated Solid Waste Management Plan (ISWMP) is therefore a complex process that requires coordinated institutional efforts. Although its implementation may be demanding, adopting appropriate waste management strategies represents an important first step towards improving campus sustainability and supporting the transition to greener higher education institutions [15], [1].

The literature consistently highlights that successful waste management strategies require a thorough understanding of the behaviours, recycling habits, and perceptions of those who generate waste within higher education institutions [16]. Environmental education also plays a fundamental role by increasing awareness of the consequences of unsustainable waste disposal practices. Common barriers to effective recycling include limited environmental knowledge, inadequate recycling facilities, and the absence of clear information regarding waste segregation procedures [1]. Conversely, well-designed waste management programmes can reduce disposal costs while improving environmental quality, health, and safety across university campuses [15], [4].

B. HEIs community's waste management knowledge, attitude and practices (KAP)

The community of a higher education institution typically comprises students, academic staff, administrative personnel, and operational employees. Among these groups, students are often recognised as future leaders and agents of social transformation, making them key contributors to sustainable development [13], [17]. Consequently, higher education institutions have an important responsibility to promote sustainable behaviours throughout their entire community [11].

Previous studies have shown that awareness of the negative consequences of improper waste disposal does not necessarily translate into environmentally responsible behaviour. Abubakar et al. [18] and Smith [19] argue that limited knowledge of environmental regulations, together with low levels of environmental concern, often results in inappropriate waste disposal practices and poor environmental stewardship. Similarly, individuals with negative environmental attitudes have been found to be less likely to engage in sustainable environmental behaviours.

Environmental education has consistently been identified as a key mechanism for promoting positive changes in knowledge, attitudes, and behaviours related to waste management. Several authors argue that educational interventions can improve environmental awareness among both students and staff, ultimately encouraging more sustainable waste management practices [20], [21], [13]. Consequently, educational programmes should be considered an essential component of institutional waste management strategies.

Waste recycling behaviour is influenced by a combination of social, psychological, and contextual factors [3].

Consequently, understanding the knowledge, attitudes, and practices (KAP) of the university community is fundamental to the successful design and implementation of waste management strategies [14]. Interviewing members of the community therefore represents an appropriate starting point for identifying behavioural barriers and opportunities to strengthen institutional sustainability initiatives.

Numerous KAP studies related to waste management have focused on households and municipal solid waste management [22], [23]. During the past decade, research examining students' environmental knowledge and recycling behaviour has also increased considerably [24], [25], [17]. However, relatively few studies have adopted a comprehensive KAP approach that includes the entire university community—students, academic staff, administrative personnel, and operational employees—particularly within higher education institutions located in low- and middle-income countries [14]. Addressing this gap, the present study explores the waste management knowledge, attitudes, and practices of the ESPOL community in Ecuador and identifies evidence-based strategies to strengthen sustainable waste management within the institution.

III. Methods and Data

A. Context of study area

This study was conducted at the Gustavo Galindo Velasco campus of Escuela Superior Politécnica del Litoral (ESPOL), a public higher education institution located in Guayaquil, Ecuador. The campus covers approximately 771 hectares, including a protected forest, and hosts around 8,200 undergraduate and postgraduate students, 756 academic staff (lecturers, professors, and researchers), and 929 administrative and operational employees.

ESPOL is a comprehensive university that includes residential facilities for international students, food courts, sports facilities, scientific research centres, a science park, a knowledge park, two shallow lakes, a central library, and multiple academic buildings. It is recognised as the highest-ranked public university in Ecuador and, according to the UI GreenMetric World University Rankings, it is the country's leading green university, ranking 121st among 1,476 universities worldwide. In addition, ESPOL has a dedicated sustainability department responsible for promoting environmental management, circular economy initiatives, and sustainability programmes across its campuses.

B. Research Approach

This study adopted an interpretivist research philosophy, as the objective was to understand how members of the university community perceive and experience waste management within their institutional context. Interpretivism assumes that reality is socially constructed and is therefore appropriate for exploring individual perceptions, behaviours, and experiences [26]. Consistent with this philosophical position, an inductive research approach was selected to allow patterns and explanations to emerge from participants' perspectives rather than testing predefined hypotheses [26]. Data were collected at a single point in time; therefore, the study followed a cross-sectional design [27].

Although previous studies on waste management and Knowledge, Attitudes and Practices (KAP) have predominantly employed quantitative or mixed-method approaches [24], [22], [23], [21], [17], qualitative methods have increasingly been recognised as valuable for exploring perceptions, experiences, and behavioural factors [26]. Qualitative interviews provide richer contextual information than structured surveys and facilitate a deeper understanding of the motivations underlying environmental behaviours [26]. This approach is particularly appropriate when the objective is to explore meanings and identify behavioural drivers rather than quantify responses [26].

Accordingly, this study employed a qualitative multi-method design based on semi-structured interviews complemented by field observations. Both primary and secondary data were used. Secondary sources informed the literature review and research design, while primary data were collected specifically for this study. Primary data provide current information directly aligned with the research objectives, despite requiring greater time and resources for collection [26]. Overall, the study followed an inductive, exploratory, and explanatory research design that generated empirical evidence on waste management behaviours within a higher education institution [26].

To the authors' knowledge, relatively few qualitative KAP studies have examined the knowledge, attitudes, and practices of the entire university community—including students, academic staff, administrative personnel, and operational employees—within the context of waste management in Ecuadorian higher education institutions. This methodological approach therefore contributes additional behavioural evidence to support the design of sustainable campus strategies.

C. Sample Data Collection

Given the size of the ESPOL community, interviewing the entire population was neither feasible nor necessary for the purposes of this study [26]. Instead, a homogeneous purposive sampling strategy was adopted to recruit participants capable of providing rich and relevant information about waste management practices within the university [26]. This non-probability sampling technique is widely used in qualitative research when the objective is to obtain in-depth insights rather than statistical generalisation.

Sample size was determined according to recommendations for qualitative research. Previous studies suggest that approximately 20 to 30 interviews are generally sufficient to achieve data saturation, particularly when interviews involve extensive probing and participants share similar characteristics [27]. Accordingly, this study planned between 20 and 30 participants and concluded data collection after conducting 24 interviews, when no substantially new information emerged from subsequent interviews.

Primary data were collected through 24 semi-structured online interviews with members of the ESPOL community,

including students, academic staff, administrative personnel, and operational employees. Semi-structured interviews were selected because they provide sufficient flexibility to explore participants' perceptions while maintaining consistency across interviews [26]. An interview protocol containing 24 open-ended questions covering the three dimensions of the Knowledge, Attitudes and Practices (KAP) framework was developed in advance to ensure methodological consistency and improve the quality of the data collection process [26]. All interviews were conducted through Zoom or Microsoft Teams and recorded with participants' consent for subsequent analysis.

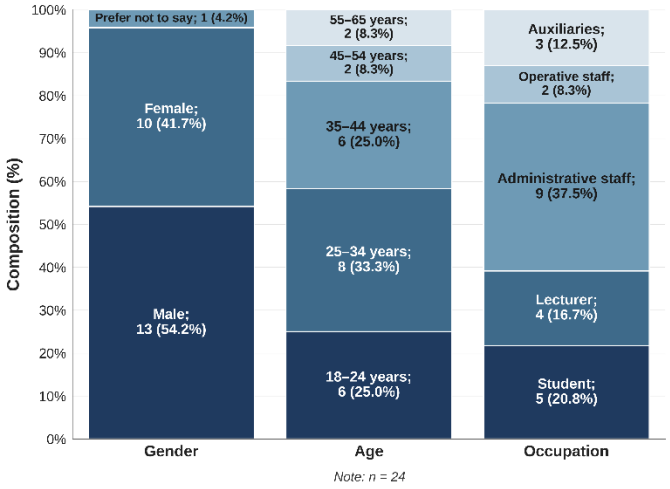


Fig. 1 Distribution of interview participants.

Figure 1 presents the demographic characteristics of the participants. The sample was intentionally balanced to capture diverse perspectives across the university community. Equal representation was achieved by gender and executive positions (administrative staff and academic personnel), while most participants were between 25 and 45 years old. This diversity of participants provided a broad understanding of waste management knowledge, attitudes, and practices across different institutional roles.

IV. Research and Discussion

The qualitative data obtained from the semi-structured interviews were analyzed using thematic analysis supported by NVivo software. Audio recordings were transcribed verbatim, complemented with field notes collected during the interviews and the campus visit, and subsequently coded following an iterative analytical process. Consistent with previous qualitative research [28], the analysis involved familiarization with the data, initial coding, identification of recurrent themes, refinement of categories, and interpretation of the findings. This systematic process enhanced the credibility of the analysis by ensuring that themes emerged directly from participants' perspectives rather than from predefined assumptions [28].

The findings are presented according to the Knowledge, Attitudes and Practices (KAP) framework, which provides the conceptual basis of this study. In addition, participants' recommendations for improving waste management are presented as a fourth analytical dimension because they offer practical insights for strengthening sustainable campus strategies. Rather than reporting the interview responses descriptively, each subsection integrates the empirical findings with previous research to explain how behavioral factors influence waste management practices within the university context.

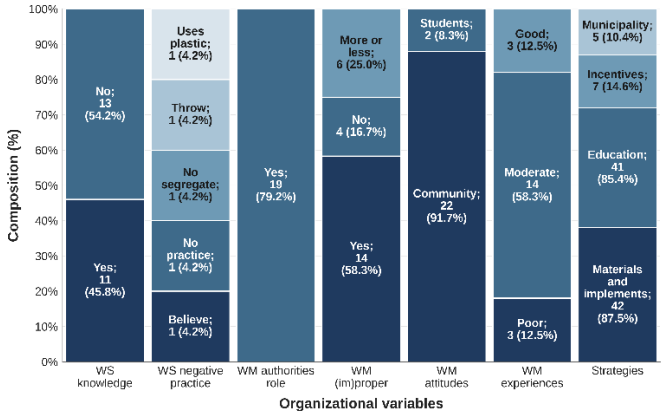


Fig. 2 Summary of participants' responses regarding waste management (WM) knowledge, attitudes, experiences, and suggested institutional strategies.

Figure 2 summarizes the main themes that emerged from the interviews and illustrates the relationship between participants' knowledge, attitudes, practices, and proposed institutional strategies. The following sections discuss these findings by highlighting the principal behavioral barriers, existing good practices, and opportunities to improve waste management at ESPOL.

A. *Knowledge*

The findings reveal important knowledge gaps regarding waste management among members of the ESPOL community. As shown in Table 1, 62.5% of participants reported limited or no knowledge of the concept of waste management, while 54.2% indicated that they were unfamiliar with waste segregation or classification procedures. Even among respondents who stated that they understood waste segregation, most described only a basic understanding, suggesting that their knowledge was insufficient to support appropriate waste disposal practices.

TABLE I
PARTICIPANTS' KNOWLEDGE REGARDING WASTE MANAGEMENT (N = 24)

Knowledge question	Yes n (%)	More or less n (%)	No n (%)	Don't know n (%)
K1. Explain the meaning of waste management.	9 (37.5)	9 (37.5)	6 (25.0)	0 (0.0)
K2. Describe waste disposal methods.	12 (50.0)	3 (12.5)	9 (37.5)	0 (0.0)
K3. Explain waste segregation.	11 (45.8)	0 (0.0)	13 (54.2)	0 (0.0)
K4. Describe the effects of proper and improper waste management.	14 (58.3)	6 (25.0)	4 (16.7)	0 (0.0)
K5. Explain how to dispose of waste correctly at ESPOL.	11 (45.8)	6 (25.0)	7 (29.2)	0 (0.0)
K6. Identify the role of ESPOL and municipal authorities in waste management.	19 (79.2)	0 (0.0)	0 (0.0)	5 (20.8)

K7. Describe effective waste management practices in HEIs.	9 (37.5)	4 (16.7)	11 (45.8)	0 (0.0)

These findings are of particular concern because environmental knowledge is widely recognised as a prerequisite for effective waste management. Previous studies have shown that individuals with a better understanding of waste management concepts are more likely to adopt sustainable environmental behaviours and actively participate in recycling programmes [18], [19], [17]. Consequently, the limited knowledge identified at ESPOL may constitute one of the principal barriers to achieving effective waste segregation and improving institutional recycling performance.

Participants also demonstrated limited knowledge regarding waste treatment and disposal methods. Landfilling and incineration were the most frequently mentioned disposal options, whereas considerably fewer respondents referred to more sustainable alternatives such as recycling, composting, anaerobic digestion, or material recovery. This finding suggests that waste management is generally perceived as a disposal process rather than as a resource recovery system, which contrasts with contemporary sustainability and circular economy approaches.

Although participants showed limited knowledge of waste management concepts, a greater proportion (58.3%) correctly identified the environmental threats associated with improper waste management (Table 1). However, when asked about the environmental, economic, and social benefits of proper waste management, most respondents struggled to provide detailed explanations. This contrast suggests that participants are generally aware that poor waste management is harmful but possess only limited understanding of the broader benefits that sustainable waste management can generate. Similar findings have been reported by Abubakar et al. [18] and Smith [19], who argue that recognising environmental problems does not necessarily translate into environmentally responsible behaviour unless individuals also understand the benefits of adopting sustainable practices.

The interviews further revealed that knowledge deficiencies directly affect participants' daily behaviours on campus. Approximately one quarter of respondents who indicated that they understood waste segregation reported difficulties when disposing of waste because recycling stations contained unclear labels or mixed waste streams. Consequently, participants frequently expressed uncertainty about the correct disposal option, resulting in improper waste segregation and reduced confidence in the recycling system. These findings indicate that environmental knowledge alone is insufficient when institutional infrastructure and communication do not adequately support appropriate waste management behaviours.

Figure 2 complements these findings by illustrating participants' perceptions regarding institutional responsibility for waste management. Most respondents (79.2%) believed that both ESPOL and the municipal authorities should work collaboratively to improve waste management, while only a small proportion considered that the university should act independently. Participants also emphasised the influential role of lecturers in promoting environmental awareness and highlighted the need for stronger institutional leadership, clearer communication, and more visible sustainability initiatives. These perceptions reinforce previous studies that identify institutional commitment and stakeholder engagement as essential components of successful waste management programmes in higher education institutions [16].

Overall, the findings indicate that the principal challenge at ESPOL is not a lack of environmental concern but rather insufficient environmental knowledge combined with limited institutional guidance. Participants generally expressed willingness to adopt sustainable waste management practices; however, uncertainty regarding waste segregation procedures, inadequate information, and inconsistent recycling infrastructure reduce their ability to translate positive intentions into appropriate behaviours. Therefore, strengthening environmental education and improving communication should be considered priority actions for enhancing waste management performance and supporting sustainable campus strategies.

B. Attitudes

Although participants demonstrated important knowledge gaps regarding waste management, the interviews revealed a generally positive attitude towards environmental responsibility and the need to improve waste management practices at ESPOL. As illustrated in Figure 2, most respondents (22 out of 24 participants) considered waste management to be a shared responsibility involving the entire university community. At the same time, 14 participants emphasised that the primary responsibility should be jointly assumed by ESPOL and the municipal authorities, recognising that institutional support is essential for creating an effective waste management system. Only two respondents considered students to be the main responsible group due to their larger population on campus, while three participants also highlighted the role of the national government in supporting institutional waste management initiatives.

These findings indicate that participants perceive waste management as a collective responsibility rather than an individual obligation. This perception is consistent with previous studies, which emphasise that successful waste management programmes require active collaboration among institutional authorities, local governments, and the university community [16], [3]. Participants repeatedly expressed those individual efforts are unlikely to produce meaningful improvements without visible institutional leadership, clear environmental policies, and adequate waste management infrastructure.

Participants also described their overall experience with waste management on campus. As shown in Figure 2, most respondents (14 participants) rated their experience as moderate, whereas only three considered it good, and another three described it as poor. Interestingly, participants who reported a positive experience generally justified their responses by referring to the availability of waste bins rather than to the effectiveness of the overall waste management

system. Conversely, respondents who expressed dissatisfaction associated their experiences with overflowing or dirty bins, unclear waste segregation instructions, inconsistent recycling practices, and limited environmental communication.

These findings suggest that participants evaluate waste management primarily through their daily interactions with the campus infrastructure. Consequently, even individuals with positive environmental attitudes may become discouraged when institutional conditions do not facilitate appropriate waste disposal behaviours. Similar observations have been reported by Tangwanichagapong et al. [1] and Bahçelioğlu et al. [2], who identified inadequate infrastructure, insufficient environmental communication, and poor maintenance of recycling facilities as common barriers to effective waste management in higher education institutions.

Another important finding emerging from the interviews is the discrepancy between environmental attitudes and environmental knowledge. Participants consistently expressed willingness to reduce waste generation, improve recycling practices, and contribute to a cleaner campus. However, many also acknowledged uncertainty regarding correct waste segregation procedures and recognised that limited environmental education constrained their ability to act consistently with their positive intentions. This finding supports the Knowledge–Attitudes–Practices (KAP) framework, which proposes that favourable attitudes alone are insufficient to promote sustainable behaviours when they are not supported by adequate knowledge and enabling institutional conditions [14], [20].

Overall, the findings indicate that the ESPOL community exhibits a favourable disposition towards improving waste management and actively recognises the importance of institutional collaboration. Nevertheless, positive attitudes are not consistently translated into appropriate environmental practices because participants perceive important barriers related to environmental knowledge, communication, and infrastructure. These results reinforce the need for integrated strategies that combine environmental education with institutional support, enabling the university community to transform positive attitudes into consistent waste management behaviours.

C. Practices

The interviews revealed that, despite the knowledge gaps identified in the previous section, members of the ESPOL community have already incorporated several environmentally responsible practices into their daily routines. As illustrated in Figure 3, the most frequently reported behaviour was carrying a reusable water bottle (22 participants), followed by attempting to segregate waste on campus (14 participants). Participants explained that the widespread availability of drinking water refill stations across the campus encourages the use of reusable bottles, reducing both plastic consumption and personal expenses.

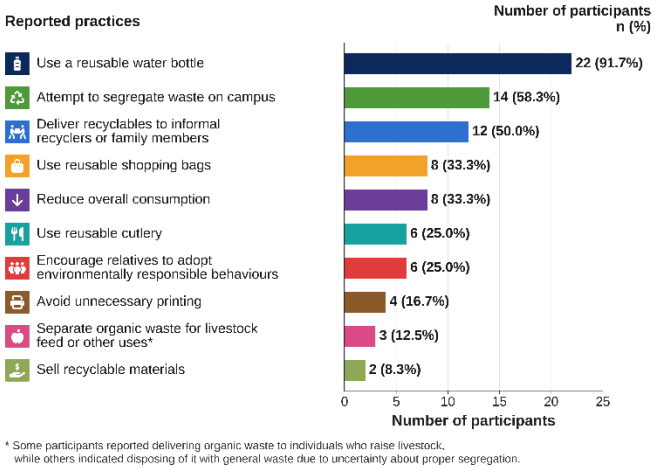


Fig. 3 Waste management practices reported by participants (n=24).

Beyond these two predominant practices, respondents described a wide range of pro-environmental behaviours. These included collecting recyclable materials to deliver them to informal recyclers or family members engaged in recycling activities (12 participants), carrying reusable shopping bags to reduce plastic consumption (8 participants), reducing overall consumption (8 participants), carrying reusable cutlery (6 participants), encouraging relatives to adopt environmentally responsible behaviours (6 participants), avoiding unnecessary printing (4 participants), and, in a few cases, selling recyclable materials themselves (2 participants). Although these practices varied in frequency, together they demonstrate an encouraging level of environmental awareness and personal commitment within the university community.

With respect to organic waste, participants reported different disposal behaviours. Some indicated that they separated organic waste to deliver it to individuals who raise livestock, while others admitted disposing of organic waste together with general waste because they were uncertain about the correct segregation procedure. These responses further reinforce the findings presented in the Knowledge section, suggesting that positive environmental intentions are often constrained by insufficient knowledge and limited guidance regarding appropriate waste segregation.

An important finding emerging from the interviews is that behavioural willingness exceeds behavioural capability. Although many respondents expressed their intention to segregate waste correctly, they frequently encountered barriers that prevented them from doing so. Participants reported difficulties associated with overflowing or dirty bins, insufficient recycling stations, unclear signage, inconsistent waste collection practices, lack of motivation, and uncertainty regarding the appropriate disposal category. Consequently, several respondents acknowledged that they sometimes disposed of waste incorrectly despite their willingness to follow sustainable practices.

These findings are consistent with previous research identifying inadequate infrastructure and poor communication

as major barriers to effective waste management in higher education institutions [1]. Similar studies have shown that environmental behaviour is strongly influenced by contextual factors rather than individual motivation alone. Therefore, providing convenient infrastructure, clear waste segregation information, and continuous environmental communication can substantially increase participation in recycling programmes [15], [16].

The interviews also revealed that nine of the participants who reported limited knowledge of waste segregation had no intention of separating waste on campus, primarily because they perceived the recycling stations as confusing or ineffective. This finding highlights the close relationship between knowledge and practice proposed by the KAP framework. Without adequate environmental education and clear operational guidance, individuals may choose not to engage in waste segregation even when they express positive environmental attitudes.

Overall, the findings indicate that the ESPOL community already demonstrates a range of positive waste management practices that provide a strong foundation for future sustainability initiatives. However, these behaviours remain inconsistent because they are not sufficiently supported by environmental education, effective communication, and institutional infrastructure. Rather than reflecting a lack of environmental commitment, participants' practices suggest that improving the conditions under which waste is managed on campus would enable existing positive behaviours to become more frequent and effective.

D. Strategies for Sustainable Campus Management

Beyond identifying the community's knowledge, attitudes, and practices, participants proposed several strategies to strengthen waste management at ESPOL. As illustrated in Figure 4, five major categories of recommendations emerged from the thematic analysis: (1) improving waste management infrastructure, materials, and operational processes; (2) strengthening environmental education; (3) implementing incentives and awareness campaigns; (4) increasing collaboration with municipal authorities; and (5) establishing regulations and enforcement mechanisms. These findings indicate that participants perceive waste management as a multidimensional challenge requiring both behavioural and institutional interventions.

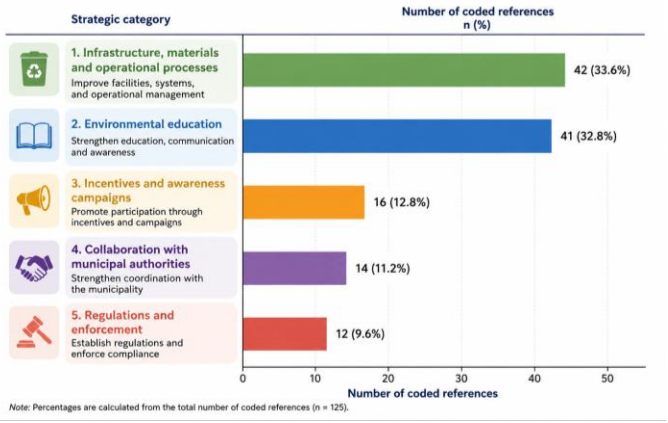


Fig. 4 Strategic categories proposed by participants to improve waste management at ESPOL.

The most frequently mentioned category concerned the improvement of infrastructure, materials, and operational processes (42 coded references). As detailed in Figure 5, participants emphasised the need for additional recycling stations, clearer bin labels, improved waste segregation systems, more frequent waste collection, cleaner recycling points, and better maintenance of existing facilities. Respondents also recommended increasing the availability of information panels, establishing sustainability programmes, setting institutional waste reduction goals, and strengthening collaboration with external organisations involved in recycling. These suggestions reflect the practical difficulties reported throughout the interviews and reinforce previous findings that convenient infrastructure and efficient operational systems are fundamental for encouraging sustainable waste management behaviours [15], [1].

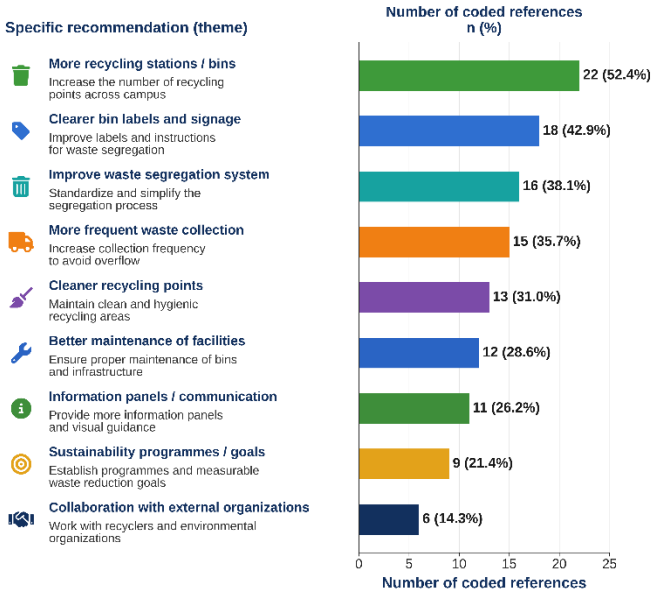


Fig. 5 Specific recommendations related to infrastructure, materials and operational processes.

The second most frequently cited strategy was environmental education (41 coded references). As presented in Figure 6, participants consistently highlighted the need for continuous educational programmes, dynamic awareness campaigns, periodic communication through institutional channels and social media, and clear guidance on waste segregation procedures. Several respondents suggested integrating environmental education into university activities, while others recommended providing training not only to students but also to academic staff, administrative personnel, and operational employees. These findings reinforce the results presented in the Knowledge section, where limited understanding of waste management emerged as one of the principal barriers to appropriate waste segregation. Previous studies similarly conclude that environmental education is essential for increasing environmental awareness, improving recycling behaviour, and fostering long-term behavioural change within higher education institutions [20], [21], [25].

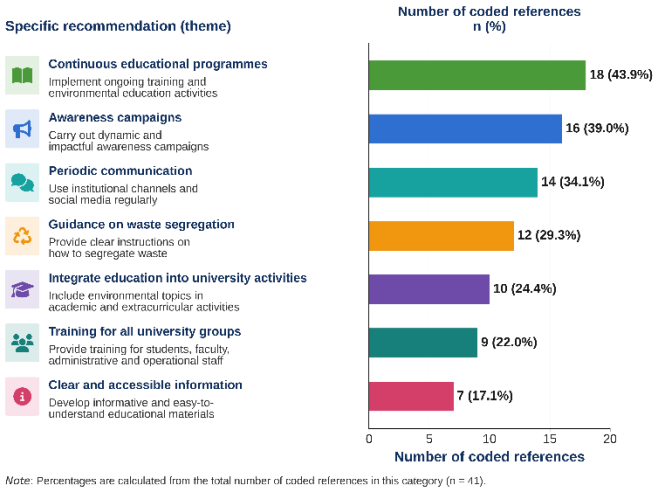


Fig. 6 Specific recommendations related to environmental education.

Participants also recognised the importance of motivational strategies to encourage active participation in waste management initiatives. Suggestions included incentive programmes, competitions, recognition schemes, and environmental campaigns capable of maintaining long-term community engagement. In addition, several respondents proposed stronger collaboration between ESPOL and the municipal authorities to improve waste collection services and establish shared responsibilities for waste management. A smaller group suggested that environmental regulations should be accompanied by enforcement mechanisms and sanctions, arguing that educational initiatives alone may not be sufficient to change deeply rooted behaviours. Although opinions differed regarding the extent to which punitive measures should be implemented, participants generally agreed that institutional leadership and clear policies are necessary to support sustainable waste management practices.

Collectively, these findings suggest that improving waste management at ESPOL requires a comprehensive institutional approach rather than isolated interventions. Participants did not perceive infrastructure, education, communication, or institutional policies as independent solutions; instead, they viewed them as complementary components of an integrated waste management system. This perspective is consistent with previous studies emphasising that sustainable campus initiatives are most effective when behavioural interventions are combined with organisational support, appropriate infrastructure, and stakeholder participation [3], [16], [5].

Overall, the proposed strategies closely reflect the barriers identified throughout the interviews. Limited environmental knowledge explains the demand for educational programmes; difficulties in waste segregation justify the need for improved infrastructure and clearer communication; and participants' positive environmental attitudes support the implementation of incentive-based initiatives capable of reinforcing existing sustainable behaviours. Consequently, the evidence suggests that ESPOL already possesses an engaged university community willing to contribute to more sustainable waste management. The challenge now lies in transforming this willingness into consistent environmental practices through integrated, evidence-based institutional strategies.

V. Conclusions, Limitations and Future Research

The findings of this study suggest that waste management practices within the studied higher education context are shaped by the interaction between environmental knowledge, attitudes, practices, and institutional conditions. Although members of the ESPOL community generally expressed positive environmental attitudes and reported several sustainable practices, important knowledge gaps and operational barriers continue to limit effective waste segregation and recycling across the campus. These findings indicate that improving waste management requires not only adequate infrastructure but also a comprehensive understanding of the behavioural factors that shape environmental practices.

A major contribution of this research is the application of a qualitative Knowledge, Attitudes and Practices (KAP) approach to investigate waste management behaviour within a higher education institution. Unlike most previous KAP studies, which have predominantly relied on quantitative surveys, this study provides in-depth behavioural evidence obtained through qualitative interviews with students, academic staff, administrative personnel, and operational employees. To the authors' knowledge, this represents one of the first qualitative KAP studies examining the entire university community within the context of waste management in an Ecuadorian higher education institution.

The findings revealed that 62.5% of participants had limited or no knowledge of waste management concepts, while 54.2% were unfamiliar with waste segregation procedures. Nevertheless, participants consistently demonstrated positive environmental attitudes and reported several sustainable practices, including the use of reusable products, voluntary recycling initiatives, and efforts to reduce waste generation. These results suggest that the principal challenge is not a lack

of environmental commitment but rather insufficient environmental education, communication, and institutional support. Consequently, strengthening environmental literacy should become a strategic priority for improving waste management performance within the university.

Participants identified environmental education and improvements in waste management infrastructure and operational processes as the two highest priorities for strengthening campus sustainability. Continuous educational programmes, awareness campaigns, clear waste segregation systems, well-designed recycling stations, effective communication, and institutional leadership were consistently perceived as essential for transforming positive attitudes into consistent environmental practices. Implementing these evidence-informed strategies may contribute to improving waste segregation and community participation while strengthening ESPOL's broader sustainability performance.

Beyond its practical implications for ESPOL, this study contributes to the growing body of knowledge on sustainability in higher education by demonstrating the value of integrating behavioural evidence into institutional decision-making. The findings suggest that universities seeking to improve campus sustainability should move beyond infrastructure-centred approaches and incorporate systematic assessments of the knowledge, attitudes, and practices of their communities when designing waste management policies and interventions.

Several limitations should be considered when interpreting these findings. First, the study adopted a cross-sectional qualitative design based primarily on participants' self-reported experiences and practices. Therefore, the findings capture perceptions at a specific point in time and may be subject to social desirability bias, particularly when participants describe environmentally responsible behaviours. Second, although field observations complemented the interviews, the interviews constituted the primary source of analytical evidence, and the observational data were not incorporated through a systematic triangulation procedure. In addition, the study did not include a systematic physical or volumetric characterization of campus waste. Consequently, the reported practices should be interpreted as perceived or self-reported behaviours rather than as direct measures of actual waste segregation performance. Finally, the purposive sample of 24 participants was designed to obtain diverse and information-rich perspectives across the university community and achieved qualitative data saturation; however, the findings are context-specific and are not intended for statistical generalization to other higher education institutions.

Future research should evaluate the long-term effectiveness of environmental education programmes and institutional sustainability initiatives through longitudinal studies. Future studies could also complement qualitative KAP assessments with systematic waste audits or physical waste characterization to compare self-reported practices with observed waste segregation patterns. Multicampus studies could further examine whether the behavioural barriers identified in this research are also present in other higher education contexts. Further investigations could also explore how digital communication, social media, and cultural factors influence environmental behaviour and support the adoption of sustainable waste management practices within higher education institutions.

Overall, the findings indicate that sustainable waste management in higher education depends not only on infrastructure but also on understanding and influencing the behaviour of the university community. Integrating behavioural evidence into institutional decision-making may therefore represent an important component in the design of more effective and sustainable campus strategies.

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