ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
CJSSR
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.04 (2025)

WASTE MANAGEMENT AND SINGLE-USE PLASTIC REDUCTION IN PUBLIC SCHOOLS OF ISLAMABAD: EVIDENCE FROM PRACTICE, PRIORITIES AND SDG PATHWAY MAPPING

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Abstract

Schools are high-frequency waste-generation settings where daily routines, canteen operations, and segregation infrastructure determine whether "zero-waste culture" becomes practice rather than messaging. In Pakistan's federal-capital context, (Federal Directorate of Education) FDE institutions can serve as model sites for operationalizing responsible consumption routines aligned with SDG 12. This study assessed prevailing zero-waste practices in FDE schools and colleges in Islamabad and explored leaders' strategy preferences for reducing single-use plastics, with cautious interpretation of SDG and climate pathways. A parallel mixed-methods design was used. Quantitative data captured nine institutional practice indicators from 314 valid responses for the waste-management domain. Qualitative data comprised 20 semi-structured interviews with heads. The strands were examined individually and joined together by means of a combined display and storytelling weaving. The minimal individual paper use (97%), and awareness campaigns (87%) were frequently reported. The avoidance behavior bag-related was also not very weak (73% avoiding plastic bags; 79% promoting fabric bags). However, the practices related to the system dependence were inconsistent such as the use of different bins to key streams (50%), student sorting engagement (57%), and digital reading routines (45%). The most underperforming (25%), was canteen use of reusables. Interviews explained these gaps through vendor governance, procurement defaults, limited monitoring capacity, infrastructure shortfalls, and affordability constraints. FDE institutions demonstrate strong normative readiness, but deeper zero-waste operationalization requires canteen-focused governance and standardized segregation systems. SDG 12 alignment is strongest; broader SDG and climate implications should be treated as pathways contingent on implementation quality.

Keywords: Single-use plastics; School canteens; Waste segregation; Zero-waste culture; Sustainable procurement; SDG 12

1. Introduction

1.1. Background and rationale

Plastic pollution and municipal solid waste have moved from being purely "sanitation issues" to being framed as governance, public health, and climate-linked sustainability problems. Globally, plastic production and plastic waste have expanded rapidly over recent decades, and the prevailing linear pattern of consumption, disposal, and leakage into land and waterways continues to intensify environmental risk (UNEP, 2023). This risk profile is not limited to industrial zones or coastal cities: institutional micro-systems, particularly schools, repeatedly generate high-frequency waste streams through food packaging, single-use items, paper consumption, and inadequate source segregation routines.

There are three reasons why schools are a strategically relevant environment. To start with, they establish concentration on daily consumption in foreseeable areas (canteens, corridors, classrooms) where routines which can be measured can be restructured. Second, schools can be considered a laboratory of norms where environmental behavior may be transformed into habitual, but not episodic. Third, schools are policymaking facilities: decisions by the leadership on rules, monitoring and procurement can be swiftly converted into practice than

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ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
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CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
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extensive popular campaigns. Practically, the necessary transformation of a school to the use of reusable cups can occur in several weeks in case the canteen contract and the system to monitor the compliance is coordinated, yet the multi-layer governance cycles are often required to make a change throughout the whole city (UNEP, 2018; UNEP, 2021).

The reasoning is quite well in line with SDG 12 responsible consumption and production, especially the goals that are concerned with waste prevention, reduction, recycling, and reuse. By making waste reduction, segregation, and decreasing the use of single-use products normalized in school systems, school systems operationalize SDG 12 at the institutional level instead of it as an abstract agenda (United Nations, 2015). However, the effectiveness of school-based sustainability depends on whether "awareness actions" are matched by infrastructure and enforceable routines, especially in high-waste points such as canteens and vendor-managed food services.

Within this problem space, the present study examines zero-waste culture and waste management practices in Federal Directorate of Education (FDE) institutions in Islamabad, combining leadership perspectives and institution-level practice indicators to identify both strengths and implementation gaps.

1.2. Problem statement in FDE context

Pakistan's environment policy has increasingly recognized plastic as a priority pollutant. Islamabad Capital Territory has had regulatory action and enforcement attention on plastic bags for several years, including measures communicated through official channels. More broadly, policy summaries indicate a pattern of phased restrictions and enforcement variation across jurisdictions, with Islamabad often cited as a relatively stronger enforcement site compared to other regions (SWITCH-Asia, 2025). It is an accepted fact that single-use plastic not only harms the land but also causes severe damage to marine life. Due to its light weight and easy purchase, it has become the favorite product of all. Despite efforts to recycle plastic, the destruction outweighs its utility (Reddy, Reddy, Subbaiah & Subbaiah, 2014). There is a need for comprehensive waste management framework to resolve the issue of environmental degradation (Bano, Rafiqu-uz-Zaman & Khalid, 2024). Schools can be a role model in reducing plastic waste, and the learners are taught about waste management so that it enables the consciousness of environment in the learners, which can be further linked in the community (Texas Disposal Systems, 2018). The FDE context makes this challenge particularly consequential because FDE institutions sit in the federal capital and can serve as a visible model for institution-led sustainability. At the same time, operational realities inside schools can dilute policy intent if the systems for implementation are not explicit and enforceable. There a mixed method approach was adopted with 314 participants responding to the quantitative strand and 20 participants for the indepth interviews to address the coherent zero-waste culture is being operationalized through aligned leadership strategies, institutional routines, and enabling infrastructure, particularly for single-use plastics and segregation practices.

2. Research aim, objectives, and research questions

Aim. The overall aim of this study is to assess the current state of zero-waste culture and waste-management practices in FDE schools and colleges in Islamabad, alongside leaders' perspectives on reducing single-use plastics, and to examine how these efforts conceptually connect with selected SDGs and climate concerns.

Objectives. As framed in the project file, the study pursues four objectives:

1. Gather school leaders' perspectives regarding zero-waste culture in schools.
2. Identify strategies for avoiding single-use plastic to promote sustainability.
3. Determine prevailing zero-waste practices in schools.

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4. Examine linkages of zero-waste culture with SDG 1, 4, 8, 12, 13, 14, and 15, and how this can address climate change alongside SDG attainment.

Research questions. The study is guided by the following research questions:

1. What are the prevailing zero-waste practices in schools?
2. What strategies or steps can be taken to avoid single-use plastic to achieve sustainability?

These questions are addressed through a parallel mixed-methods approach that allows institutional practice indicators to be interpreted alongside leadership accounts of implementation mechanisms and constraints.

2.1. Study contributions and paper organization

There are four contributions to this study. Firstly, it offers a snapshot of institution-oriented zero-waste culture in a federal-capital schooling system on a consolidated analytic sample (N = 314) that defines the widespread of core practices that encompass awareness, paper minimization, segregation and plastic avoidance.

Second, it adds leadership-grounded operational insight from head interviews (n = 20), clarifying why certain actions, especially canteen-based reusables and bin segregation, lag behind more common awareness and paper-saving behaviors.

Third, it strengthens policy relevance by structuring findings around implementable levers that school leadership can realistically control, including vendor rules, monitoring, and routine enforcement, consistent with broader guidance that single-use plastics reduction succeeds when governance tools complement behavior-change messaging (UNEP, 2018; UNEP, 2021).

Fourth, it positions school-based waste management as a practical entry point for SDG 12 implementation while treating broader SDG linkages as pathways rather than overstated outcomes, keeping claims aligned with the data.

3. Literature Review

3.1. Zero-waste culture in educational institutions

“Zero-waste” in educational settings is increasingly treated as a whole-institution practice rather than a set of isolated recycling activities, because waste outcomes depend on routines, infrastructure, monitoring, and procurement choices that shape daily material flows (Rabeiy, Almutairi, Birima, Kassem & Nafady, 2023; Rodríguez-Guerreiro, Torrijos, Soto, 2024). Reviews of waste management in education-related institutions repeatedly show a common pattern: high awareness and willingness can coexist with weak separation at source and inconsistent operational systems, especially when bin infrastructure and collection pathways are not aligned (Rabeiy et al., 2023; Rodríguez-Guerreiro et al., 2024). Even where sustainability is formally promoted, implementation often stalls when initiatives rely on motivation alone rather than being embedded into daily operations and responsibilities (Mogren, 2019).

Empirical work on whole-school or whole-institution sustainability suggests that “culture” becomes observable when sustainability is expressed across **curriculum, operations, governance, and community engagement**, not only through occasional campaigns (Mogren, 2019). An example of operational nature of the zero-waste culture is an open-access school program evaluation that aligns with whole-school principals, called Recreos Residuos Cero, which combines data instruments (waste tracking) with implementation reported by teachers, demonstrates uptake, and limitations (Ballegeer, Lozano Murciego, Ferrari Lagos, Leiros, Gloder & Ruiz 2024). In addition to this, more general research on school sustainability demonstrates that leadership aspiration toward sustainability is high, along with a general awareness that sustainability is not yet a well-institutionalized part of many schools, which indicates that there is a disconnect between the intended and the enacted (Holst et al., 2025).

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From a measurement standpoint, educational waste often focusses on indicators that are feasible for institutions to report or observe, such as awareness activities, paper minimization, bin availability, and separation practices. Such indicators are useful because they mirror the practical levers schools can control (Rabeiy et al., 2023). However, literature also emphasizes that waste systems are "multi-component" and require coordination among generators, collectors, and institutional managers to avoid the common failure mode where "separated" waste is later recombined, undermining trust and compliance (Rodríguez-Guerreiro et al., 2024).

3.2. Single-use plastic reduction, with emphasis on canteens and procurement

Single-use plastics remain embedded in everyday food-service consumption, making canteens and cafeterias a predictable high-volume stream of cups, wrappers, bags, and disposable containers. Interventions in this domain typically work best when they address both material substitution (reusables, compostables where appropriate) and system conditions (collection, washing logistics, vendor requirements, and compliance) rather than treating single-use plastics as a purely behavioral choice (Caspers, Süßbauer, Coroama, & Finkbeiner, 2023). LCA-oriented research repeatedly indicates that reusable packaging can outperform single-use options under realistic reuse thresholds, but performance is sensitive to usage behavior, return rates, and operational design, which is precisely why food-service settings demand governance and logistics, not slogans (Caspers et al., 2023; Gao et al., 2025).

Within food packaging and food service applications, environmental evaluations invariably conclude that net benefit of reuse systems is determined by reuse cycles, washing efficiency, transport and consumers taking part (Caspers et al., 2023; Gao, et al., 2025). Even the best-laid plans where a school has a mandatory reuse program can result in very weak outcomes if vendors are not contractually obligated, if there are convenience barriers to students using them or if there is not any monitoring. Therefore, procurement and contracting turn out as a practical lever to limit the single-use plastics at the source, particularly in cases of food service outsourcing or semi-autonomous (Kuruneri et al., 2025).

The procurement literature subscribes to the logic in the following: sustainable procurement was labelled as mechanism for embedding sustainability into the rules of purchasing and supplier relationships, to translate policy intention into conducting routine procurement behaviours (Caruana, 2024; Kuruneri et al., 2025). Importantly, procurement is not just a "green preference" issue, as it is the institutional governance tool that can establish minimum standards for packaging, require vendor reporting and build enforcement triggers which can be of particular consideration in school canteens, where purchasing decisions occur on a daily basis, thus building up quickly (Caruana, 2024).

There is also practical methodological learning that can be derived from packaging research: interventions should be measured more thoroughly than just adoption intentions but should consider further markers of implementation, either at the system-level (use or return rates, wash capacity, compliance check, change in waste stream) (eg, Cascers et al. (2023)). Consequently, school-based plastic reduction is best thought of as a food service system redesign, in which procurement and vendor governance is the system conditional, while awareness should be thought of as a supporting system mechanism rather than the primary intervention.

3.3. School leadership and implementation governance

From an education governance perspective, school sustainability initiatives tend to succeed if they get institutionalized through routines, role clarity and accountability instead of being one-off campaigns. Work on educational change has focused on the idea that educational reforms are likely to be durable if they alter everyday practice and develop capacity throughout the school organization (Fullan, 2007). Similarly, distributed leadership perspectives underscore

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ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
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the fact that implementation depends on the way in which responsibilities are acted out through formal and informal routines by staff rather than solely on the commitment of a single leader (Spillane, 2006). Implementation research also illustrates that the quality and consistency of implementation, as well as contextual enablers such as resources, training, and administrative support, have a strong influence on program outcomes (Durlak & DuPre, 2008; Fixsen et al., 2005).

In the school sustainability literature, leadership is not framed as a motivational accessory; it is repeatedly described as the driver of organizational alignment: setting rules, enabling resources, and sustaining routines long enough for new norms to stabilize (Mogren, 2019; Holst et al., 2025). Whole-school approaches emphasize coordination across roles, including principals, teachers, students, and external partners, with leadership providing the governance architecture that converts "projects" into "processes" (Mogren, 2019).

Recent evidence on principal perspectives suggests that many principals' support sustainability as a core component of schooling yet frequently report that sustainability is not systematically embedded in day-to-day school routines, indicating organizational barriers beyond personal commitment (Holst et al., 2025). Program evaluations also show that implementation quality varies across schools, and that data-driven monitoring tools can help, but only if responsibilities and team structures are clear (Ballegeer et al., 2024).

Implementation governance becomes especially important for waste management because compliance depends on repeated micro-actions, for example correct disposal, bin placement, and vendor behavior, which require coordination and monitoring. Studies on separation practices in educational contexts show that willingness may be very high even when actual separation remains limited, indicating that the constraint is often system design and enablement, not attitudes (Rabeiy et al., 2023). As a result, leadership influence is expressed through operational decisions such as assigning monitoring roles, setting enforcement routines, standardizing bin systems, and using procurement and vendor clauses to change default consumption patterns (Holst et al., 2025; Caruana, 2024).

3.4. SDG and climate linkages, with SDG 12 centered

Educational waste management aligns most directly with **SDG 12** because SDG 12 emphasizes responsible consumption and production, including waste prevention, reduction, reuse, and recycling. The circular economy literature positions SDG 12 as a practical anchor for institutional action because it links consumption routines to material flows and governance choices rather than treating sustainability as a purely educational message (Shollo, 2025). Moreover, work mapping circular economy education argues that schools and education systems influence not only awareness but also skill and habit formation relevant to resource circularity, supporting the plausibility of schools as leverage points for SDG 12 implementation (Kruja et al., 2025; Kosta et al., 2025).

The SDG 12 framing also provides a disciplined way to avoid overstating climate claims. Waste reduction can contribute to climate mitigation through reduced production demand, lower waste transport and disposal burdens, and improved diversion pathways, but the magnitude depends on system design and lifecycle conditions, especially when substituting packaging types (Caspers et al., 2023). Therefore, SDG 12 can be treated as the central outcome domain in school waste studies, while SDG 13 linkages are best stated as pathways contingent on adoption quality and operational performance (Shollo, 2025).

In addition, sustainability and circularity research in primary education underscores that teachers and institutions often require structured training and ongoing support to integrate circularity values and waste-related concepts into teaching-learning processes, further

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ISSN P: 3006-1458
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reinforcing that SDG-aligned practice is an implementation problem as much as a knowledge problem (Kosta et al., 2025).

3.5. Conceptual frame for the study

To guide interpretation, the study adopts a pragmatic implementation lens consistent with whole-school sustainability approaches and education change theory. The resulting School Sustainability Implementation Model specifies three interacting layers through which zero-waste practices become routine in schools (Fullan, 2007; Fixsen et al., 2005; Ballegeer et al., 2024).

1. Normative layer (awareness and habits): student engagement, staff modeling, and communication campaigns that shape shared expectations about acceptable practice. This layer matters for social norm formation, but it is insufficient on its own when behaviors require enabling conditions (Mogren, 2019; Durlak & DuPre, 2008).
2. Operational layer (infrastructure and routines): bin architecture, collection schedules, storage space, and routine, as making desired behaviours easy, visible and repeatable. In implementation terms, these are the core supports that translate intentions into consistent practice (Fixsen et al., 2005; Rabeiy et al., 2023).
3. Governance and procurement layer (rules and system defaults): canteen vendor clauses, approved-item lists, procurement specifications, and monitoring routines that shift defaults away from single-use items. This layer is where leadership and administrative governance entrench practices over time and makes them less dependent upon people's goodwill (Spillane, 2006; Caruana, 2024).

The model implies uneven implementation in a situation where normative awareness exceeds operational capacity and establishment (governance) defaults. In these situations, reporting high rates of participation in campaigns while system-dependent practices (notably segregation and canteen reuse) remain low or unstable can be observed, which is consistent with findings from research on implementation focusing on infrastructure, leadership, and monitoring on a regular basis (Durlak & DuPre, 2008; Fullan, 2007; Ballegeer et al., 2024).

4. Methods

4.1. Study design (parallel mixed-methods)

This study employed a parallel mixed-methods design, in which quantitative and qualitative strands were implemented during the same overall study period, analyzed separately using strand-appropriate procedures, and then integrated at interpretation (Teddlie & Tashakkori, 2009). The quantitative part of the project was the recording of the prevalence of school-level zero-waste practices and conditions for their implementation based on structured implementing tools administered in a cross-sectional manner in FDE institutions. The qualitative strand elicited the reasoning of school heads about feasible strategies, constraints and governance mechanisms for the reduction of single-use plastics, paying special attention to the canteen practices and the routines of compliance. Integration was undertaken through a joint display and narrative weaving, enabling the study to report not only what practices exist, but also why certain practices remain uneven across institutions.

4.2. Setting and participants (FDE Islamabad)

The study was conducted in Federal Directorate of Education (FDE) institutions in Islamabad. The unit of analysis was the institution, reported by the school or college head or an officially delegated focal person. A census-style outreach was used to maximize coverage across FDE institutions, because practice prevalence and governance conditions were expected to vary by institution type and operational constraints.

Institutional heads were approached through official FDE channels. A total of 432 institutions were invited, and 314 institutions submitted complete waste-domain responses that met the

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ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
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pre-specified validity criteria and were retained for quantitative analysis (analytic response rate: 72.7%). Reporting is presented in aggregate to protect institutional and individual confidentiality.

Table 1. Study setting, participants, and analytic sample

Component	Target population and plan	Final analytic sample	Unit of analysis
Quantitative strand	FDE schools and colleges in Islamabad; planned outreach to 432 heads	314 valid responses for the waste domain	Institution (school/college)
Qualitative strand	Heads for in-depth explanation of strategy feasibility and governance	20 head interviews	Institution-level leadership perspective

4.3. Instruments and measures (A1–A5)

Data collection relied on a structured instrument set (Appendix A) designed to capture institutional practices, enabling conditions, and governance routines relevant to school-based waste minimization and single-use plastic reduction. The tools were consolidated into five components (A1 to A5) to align with the objectives and to support replication in similar school systems. Items were phrased for institution-level reporting, and the tool structure distinguishes routine, observable practices from practices that require infrastructure or vendor management.

Table 2. Instruments, constructs, and outputs (A1–A5)

Tool	Title and mode	What it measures	Primary outputs used in this study
A1	School profile and zero-waste infrastructure checklist (observation and record review)	Institutional profile, waste collection arrangements, bin availability, segregation system features	Infrastructure indicators; enabling conditions for segregation and waste routines
A2	School leader questionnaire (self-administered or interviewer-assisted)	Frequency of current practices; readiness; barriers; strategy feasibility and impact	Practice prevalence; readiness and barrier indicators; strategy ratings
A3	Waste quantification form (simple waste audit)	Approximate waste stream quantities and handling practices where implemented	Contextual confirmation of waste flow patterns (used as supportive evidence where complete)
A4	SDG and climate linkage mapping matrix	Perceived linkages between school actions and selected SDGs/climate pathways	Structured basis for SDG narrative and cautious pathway claims
A5	Semi-structured interview guide for school heads	Mechanisms, feasibility, compliance, equity constraints, and governance routines	Themes explaining implementation gaps, leverage points, and enforcement mechanisms

Operationalization of key quantitative indicators. Practice indicators were derived directly from the structured tools and harmonized into comparable categories. Nine core indicators were used to report prevalence of zero-waste and plastic-reduction actions, including awareness and paper-minimization actions, segregation availability and use, and canteen-related reduction and

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ISSN P: 3006-1458
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reuse practices. Cut points for interpretive categories were defined a priori and applied consistently across institutions.

Qualitative focus. The interview guide (A5) elicited heads' reasoning about feasible strategies, constraints, and accountability mechanisms, with particular attention to canteen operations, vendor compliance routines, and monitoring feasibility. Probes also addressed resource constraints, equity considerations, and perceived climate and SDG linkages as they relate to institutional routines rather than one-off awareness campaigns.

4.4. Data collection procedure

Data collection was conducted during the same overall study period for both strands, consistent with a parallel mixed-methods design. Administration was coordinated to standardize prompts and response options across institutions and to minimize differential interpretation.

1. Institution contact and consent. Heads were contacted through official channels and provided an information sheet describing study purpose, voluntary participation, and confidentiality. Consent was obtained prior to administering the leadership questionnaire or conducting interviews.
2. Quantitative tool administration. The leadership questionnaire and associated checklists (Appendix A) were completed by the head or designated focal person. Where a checklist item required physical confirmation, the focal person conducted a brief site walk-through, in line with the instrument instructions, before submitting the response.
3. Supporting documentation. Where feasible, respondents used non-identifying supporting evidence such as posted notices, photographs of bins or signage without school names, or procurement records at a summary level, to corroborate institutional claims. Submission of supporting evidence was optional and was not a condition for inclusion.
4. Qualitative interviews. Semi-structured interviews (Appendix A5) were conducted with 20 heads to elicit reasoning about feasible strategies, constraints, vendor governance, compliance routines, and sustainability of implementation beyond initial campaigns. Interviews were audio-recorded with permission and anonymized at transcription.

Data quality screening. Quantitative submissions were screened for completeness and internal consistency in the waste-management domain. Cases with missing core indicators, contradictory selections, or non-institutional entries were excluded from domain-level analysis. This screening yielded a final analytic sample of N = 314 institutions.

4.5. Data analysis

4.5.1. Quantitative analysis

Quantitative analysis was conducted using descriptive statistics and association checks appropriate for institutional prevalence reporting. Analyses focused on estimating practice prevalence and identifying patterning across practice types, especially differences between norm-based actions and system-dependent practices that require infrastructure, procurement alignment, or enforceable routines.

Step 1: Cleaning of data and screening for validity. Records were checked for duplicates, completeness of the waste domain and logical consistency between related items. Only those submissions that met the validity criteria pre-specified for the analyses were retained for analysis (final N = 314).

Step 2: Variable construction. Practice indicators were coded as consistent binary or ordinal, according to the codebook of instrument. Where composite summaries were reported, items were reviewed for conceptual coherence before being aggregated, and internal consistency examined if a multi-item scale was to be used.

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Step 3: Descriptive, reporting, and interpreting patterns. Results are presented in the form of proportions and frequency distributions and selected cross-tabulations in order to aid the interpretation of leverage points. Inferential claims were limited and the focus was on patterns of action which could be acted upon, instead of statistical significance alone.

4.5.2. Qualitative analysis (n = 20 interviews)

Qualitative analysis was structured as thematic analysis according to the research goals, aiming at feasibility, constraints, routines and governance mechanisms.

Step 1: Preparation. Interviews were transcribed, de-identified and checked for accuracy. Any institutional names, locations, or vendor identifiers were removed prior to coding.

Step 2: Initial coding. Coding combined deductive categories derived from the interview guide with inductive codes that emerged from the data (for example, procurement defaults, vendor incentives, enforcement fatigue, student convenience, and budget constraints).

Step 3: Theme development. Codes were clustered into higher-order themes, refined iteratively, and evaluated for internal coherence and explanatory value for quantitative patterns.

Step 4: Dependability support. A subset of transcripts and coded extracts was reviewed by a second reviewer to check code application and theme boundaries. Discrepancies were resolved through discussion and refinement of code definitions, documented in the audit trail and reflected in the codebook excerpt (Appendix B).

4.5.3. Integration procedure (joint display + narrative weaving)

Integration was undertaken after completing strand-specific analyses. Findings were compared in a joint display to identify convergence, complementarity, and divergence, and to derive meta-inferences that specify implementation levers for FDE schools and colleges, particularly around canteen practices and segregation routines.

1. Joint display construction. Quantitative prevalence results were aligned with qualitative themes that explained enabling conditions and barriers. The joint display served as the primary integration artifact and guided the structure of the integrated Results.
2. Narrative weaving. The integrated narrative was written by weaving quantitative patterns with qualitative mechanisms. Where strands diverged, divergences were interpreted as implementation-quality gaps or context-sensitive variation, rather than treated as contradictions.

4.6. Trustworthiness and rigor

Rigor was covered in the alignment of design, the transparency of operation, and the explicit integration. For the quantitative strand, validity was justified by instrument grounding in previously published school waste practice literature, codebook developed coding and documented data screening rules. For the qualitative strand, credibility and dependability were enhanced using de-identification, a documented coding trail, second reviewer checks on coded extracts and representative quotations. Integration rigor drones joined via the display logic and meta-inferences between patterns of prevalence and mechanisms of governance.

4.7. Ethics

Participation was voluntary and was on the basis of informed consent. Data were managed confidentially and aggregate reported. Interviews and questionnaire responses were anonymised and individual respondents or institutions were not identified during reporting. Any supporting materials that were optional were used solely to support claims of implementation without the collection of identifying material. Minimal risk to participants and respect for institutional norms of participation and information sharing were considered in the study procedures.

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5. Results

5.1. Quantitative results: prevailing practices (nine indicators)

The quantitative strand (N = 314 valid responses for waste management domain) gives a profile of the practice of zero waste culture in FDE institutions at a practice level. Results show a consistent pattern of norm-based and awareness-oriented actions being relatively high and the system-dependent actions that require procurement, vendor compliance or physical infrastructure are uneven.

Table 3: Prevailing Zero-Waste and Plastic-Reduction Practices in FDE Institutions (N = 314)

Indicator (institution-level practice)	Yes, n (%)	No, n (%)
Education campaigns to encourage zero-waste culture	273 (87%)	41 (13%)
Students taught to use recycled materials	220 (70%)	94 (30%)
Canteen uses reusable plates, trays, bowls, cups	79 (25%)	235 (75%)
Avoid paper waste, use both sides for printing	305 (97%)	9 (3%)
Students engaged in sorting waste	179 (57%)	135 (43%)
Digital reading or note-taking to reduce paper	141 (45%)	173 (55%)
Avoid single-use plastic bags	229 (73%)	85 (27%)
Encourage fabric bags for shopping	248 (79%)	66 (21%)
Separate bins for plastics, paper, organic waste	157 (50%)	157 (50%)

Note. Percentages are based on N = 314 valid responses for the waste-management domain.

However, there are two high-performing indicators that stand out. First, the norms of paper saving seem to be well entrenched (97%), which may mean that institutional routines that require little external coordination are easier to maintain. Second, campaign-based promotion of the zero-waste culture is also high (87%) meaning awareness and messaging as implementation tools are widely in use.

A second cluster of findings is that plastic avoidance behaviours are relatively, but not universally, common. Nearly three-quarters of institutions are saying they avoid plastic bags (73%) and a larger majority are saying they encourage fabric bags (79%). These numbers indicate substantial diffusion of bag-related norms, which may be the result of the familiarity of bag substitution behavior as a household activity, and its opportunity for reinforcement through school messaging without significant infrastructural changes.

In comparison, practices that require enabling systems are less strongly implemented. Only half of the respondents report separate bins for different types of waste (50%) and only 57% say that students are involved in sorting waste. This combination suggests that there may be willing students in many institutions, but the infrastructure to help achieve consistent source segregation is not standardized. The weakest indicator is canteen-based reusables (25%), which is notable as canteens are a concentration of single-use plastics through packaging and cups and disposable serving items. The low rate at which canteen reusables work hints that food service routines are a key implementation bottleneck, which is likely to be due to vendor incentives, procurement default and the requirement for enforceable compliance mechanisms.

Finally, digital reading and note-taking is reported by less than 50% of institutions (45%). This leads us to conclude that although paper minimization may be a powerful norm, digitization as an institutionalized practice may nonetheless be limited by the availability of devices, classroom routines, or institutional readiness.

5.2. Qualitative results: themes for plastic reduction strategies

Interviews with 20 heads produced a coherent set of strategy themes. Leaders' accounts consistently emphasized that single-use plastic reduction is feasible when it is treated as an

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institutional governance issue, not only an awareness issue. The themes below summarize the dominant solution logic expressed across interviews.

Table 4: Themes of Leader-Proposed Strategies for Reducing Single-Use Plastics (n = 20 Interviews)

Theme	Strategy emphasis	Typical mechanism in schools
A. Restrict plastics through rules and enforcement	Restrictions, school-level rules, alignment with broader policy signals	Written rules, enforcement routines, compliance checks
B. Transform canteen practices as the core intervention point	Reduce wrappers, shift to reusables, regulate vendor behavior	Vendor clauses, monitoring committees, approved item lists
C. Promote home-made lunch and reduce junk food	Reduce packaging at source by shifting consumption patterns	Parent communication, student norms, restrictions on packaged items
D. Replace plastic bags with alternatives	Encourage cloth, jute, paper alternatives	Student-led initiatives, community messaging, availability of alternatives
E. Education and student engagement as behavior-change infrastructure	Awareness as a sustained system, not occasional events	Projects, campaigns, clubs, peer influence, home spillover
F. Segregation and recycling with organics and gardening links	Segregation at source and practical reuse pathways	Labeled bins, segregation routines, composting or gardening links
G. Equity and affordability constraints	Cost sensitivity shapes feasibility and compliance	Low-cost alternatives, phased implementation, vendor affordability planning

Note. Themes represent clustered patterns across interviews; mechanisms are summarized at institution level and do not imply uniform implementation across all sites.

Two themes dominated leaders' accounts. First, leaders repeatedly treated canteen transformation as the practical hinge point for plastic reduction, emphasizing vendor governance, monitoring, and restrictions on high-waste items. Second, leaders described rule-setting and enforcement as essential because voluntary compliance is hard to sustain in high-frequency consumption settings.

A cross-cutting constraint appears in the equity theme. Several leaders highlighted affordability as a practical limiter: restrictions that increase costs for students or vendors can reduce compliance or create informal workarounds. This constraint does not negate the feasibility of plastic reduction, but it shifts attention to implementation design, for example phased adoption, feasible low-cost substitutes, and procurement conditions that do not impose unrealistic burdens on vendors.

5.3. Integrated results: alignment, divergence, and implementation gaps

Integration of the two strands clarifies where the system is already strong, where it is inconsistent, and what mechanisms plausibly explain the gaps. Overall, integration suggests a consistent "two-speed" implementation pattern: high adoption of low-cost norms and messaging, and weaker adoption of infrastructure-dependent and vendor-dependent practices.

Meta-inferences (integration product). First, awareness and paper-minimization actions appear comparatively widespread because they require low capital investment and can be implemented through messaging and informal norms; however, they do not reliably translate into waste diversion without segregation infrastructure and monitoring routines. Second, canteen and

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ISSN P: 3006-1458
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vendor-managed food services represent a governance bottleneck: where procurement defaults and vendor incentives remain unchanged, single-use plastics persist even in institutions reporting high awareness. Third, compliance is shaped less by stated policy presence than by the existence of simple enforceable routines such as bin placement rules, observable checks, and corrective feedback loops; these routines also clarify accountability across school staff and vendors.

Table 5: Joint Display of Integrated Findings: Quantitative Patterns, Qualitative Mechanisms, and Implementation Implications

Quantitative finding (N = 314)	Qualitative mechanism (n = 20)	Integrated inference	Implementation implication
Paper saving is nearly universal (97%)	Leaders view routine-setting as feasible when controlled internally	Internally governed routines stabilize faster than system redesign	Standardize paper-minimization protocols and audit compliance lightly
Campaigns are widespread (87%)	Awareness is seen as necessary but insufficient	Messaging is functioning, but needs operational backing	Link campaigns to concrete routines and monitoring indicators
Separate bins are inconsistent (50%) and sorting is mid-level (57%)	Leaders stress segregation at source and practical reuse pathways	Infrastructure and process standardization are uneven	Set minimum bin standards and clear segregation responsibilities
Digital reading is limited (45%)	Leaders imply readiness and access constraints	Paper reduction is achieved through behavioral norms more than digitization	Prioritize feasible digital routines and basic access support
Canteen reusables are rare (25%)	Canteen is described as the core intervention point with vendor rules	Vendor governance and procurement defaults are the primary bottleneck	Add vendor clauses, approved items list, and monitoring committee routines
Bag avoidance (73%) and fabric-bag promotion (79%) are relatively high	Leaders recommend alternative materials and habit-building	Household-linked behaviors diffuse more easily	Reinforce through student-led initiatives and community messaging
Teaching recycled materials is common (70%)	Leaders propose projects and engagement	Educational practices support norms but may not change waste systems alone	Tie projects to measurable operational actions, not only displays

Note. Integrated inferences are interpretive conclusions derived from cross-strand triangulation; they describe plausible mechanisms consistent with both datasets.

The greatest cross-strand alignment is evident in the difference between what the schools can control internally and what the design of the system must change. Paper-saving practices, campaigns and bag related behaviors are relatively high given that they can be sustained through norms, classroom routines and messaging. This is reinforced in the accounts of leaders

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who emphasize the feasibility of behavior change activities which can go beyond school to families.

The major divergence is in the canteen & segregation area. Quantitatively, canteen reusables is the weakest area with only 25% and the segregation infrastructure is inconsistent with 50% saying separate bins are available. Qualitatively, leaders know that the canteen is the key intervention point and often talk about vendor governance mechanisms. Taken collectively, integrated inference is that, rather than it being a lack of awareness, it is the absence of standardised procurement expectation, enforceable vendor contracts and regular monitoring capacity. This is consistent with the observation that there is still a low level of system-oriented and a high level of awareness-oriented practices.

A second implementation gap refers to digitization. Schools report strong paper saving behaviours, but digital reading is a small adoption. Say leaders accounts of digitization is much more than just an attitude, and is limited or constrained by readiness, access, and routine redesign. This gap is important because it seems that the current route to paper reduction is one that is based on conservation norms as opposed to digital transformation. As a result, scaling digital routines probably needs a separate implementation strategy, from the general awareness strategy.

Across all of the outputs of integration, there is convergence of results that point to a clear set of operational priorities: To strengthen zero-waste culture, FDE institutions seem to require minimum infrastructure standards for segregation, and some governance tools specific to canteens, such as vendor clauses, approved item lists, and monitoring committees. These actions align with the proposed mechanisms of leaders, and target the weakest quantitative indicators directly and are therefore plausible as leverage points for rapid improvement.

6. Discussion

6.1. Interpretation of key patterns

Across both strands, a common pattern emerges practices based mostly on awareness and individual discretion are common, while practices that require infrastructure, coordination, and routines that can be enforced are uneven. This divergence is consistent with the implementation research indicating that while participation can initially increase rapidly, it takes organisational supports and governance mechanisms for sustainability to occur (Durlak and DuPre 2008; Fixsen et al 2005; Rabeiy et al 2023).

The near-universal paper minimization suggests that, with control of the workflow in schools, rapid behavior change can occur with limited resource needs. By contrast, practices involving cross-actor alignment such as vendor compliance and waste handling routines are more susceptible to limits of capacity and ambiguity of roles (Fullan, 2007; Spillane, 2006).

The poor adoption of reusable options in canteens is an indicator of defaults in the system, not of poor awareness. Whereas vendors ensure packaged items are supplied and where single-use materials are the easiest to acquire, individual intentions are structurally hampered. Comparable results in food service environments have established that default positions offered and convenience have a strong influence on container decision making and outcomes (Caspers et al., 2023; Li et al., 2023).

Segregation indicators also are mixed. Separate bins may exist, but inconsistency in labelling bins, collection logistics and downstream handling may destroy credibility and compliance over time. Research about segregation within schools and campuses focuses on the importance of visible infrastructure being accompanied by proper collection and feedback to avoid backsliding (Kihila et al., 2021; Rodriguez-Guerreiro et al., 2024).

Finally, digitization offers up as a high feasibility entry point. However, from an implementation perspective it ought to be considered an enabling practice: It helps to save

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paper, but does not re-configure the material flows, which are caused using canteens and waste logistics. This distinction is important for the sequencing of reforms, and if you want to target leverage points effectively (Fixsen et al. 2005; Fullan 2007).

6.2. Why canteens and segregation are the leverage points

Integration highlights two leverage points because they are upstream in the waste system. Canteens have a waste at source impact (procurement and packaging), segregation has an impact downstream (structures collection and recovery pathways). They both need the coordination of routines and family like monitoring and not just awareness actions (Caspers et al., 2023; Kihila et al., 2021; Caruana, 2024).

The qualitative themes imply that canteens are decisive because the vendor-managed food services are operated by the contractual and market logics. With no enforceable provisions and routines for verification, single-use packaging is the default setting, even in schools with high pro-environmental messaging. This is in line with procurement literature with a focus on institutional purchasing rules being able to change system outcomes more reliably than voluntary appeals (Caruana, 2024; Li et al., 2023).

Segregation is also a leverage point but for a different reason: It makes the waste visible, assignable and measurable. When bin architecture and collection routines are standardized, schools can audit their compliance and look for bottlenecks and build the routines for students through repetition. In a situation where segregation is symbolic or inconsistently serviced, trust is destroyed and mixed waste is swiftly back-flowing (Kihila et al., 2021; Rodriguez-Guerreiro et al., 2024).

In terms of practical realities, canteen reform, waste generation at source, recovery and leakage are issues of segregation reform. Together they form a consistent track from prevention to sound handling - in accordance with the model's prediction according to which governance defaults and operational routines are a key to sustainable change (Fixsen et al., 2005; Fullan, 2007).

6.3. SDG and climate implications

The findings most directly advance SDG 12 because the observed practices map onto institutional mechanisms for waste prevention, reduction, segregation, and reuse. At school level, SDG 12 is operationalized when waste minimization and reuse become part of routine operations rather than isolated campaigns (United Nations, 2015; Mogren, 2019).

Links to SDG 13 are best framed as plausible mitigation pathways rather than direct measurement. Reduced production and disposal of single-use plastics can lower lifecycle emissions, but quantifying climate effects requires material-flow and life-cycle data beyond the present design (Li et al., 2023; Caspers et al., 2023).

For SDG 14 and SDG 15, the mechanism is reduced plastic leakage into terrestrial and aquatic ecosystems through source reduction and improved handling. In terms of education, SDG 4 is fostered through institutional education: repetitive habits, student engagement and leadership models to support sustainability as a practice of school improvement, and not of school topic (Ballegeer et al., 2024; Fullan, 2007).

6.4. Policy and practice implications for FDE

The integrated results of this are suggesting FDE implementation package that goes beyond awareness and makes zero-waste practices auditable. In terms of making it implementable the aim is to specify minimal standards, facilitate routines, and build feedback loops to keep practice under conditions of real-world constraints (Fixsen et al., 2005; Durlak & DuPre, 2008).

Minimum segregation standard and bin architecture FDE will be able to issue a simple, standardized bin and signage specification and require their consistent placement in high-waste-points. Fewer ambiguities, support for monitoring and increased reliability of student

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ISSN P: 3006-1458
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routines between institutions is standardized (Kihila et al., 2021; Rodriguez-Guerreiro et al., 2024). Canteen vendor clauses and approved-item framework: as canteens are vendor mediated, there is basically the procurement governance as the lever. Contracts can be passed to have reusable/returnable options, to limit high-waste packaging and ensure that vendors display ease to inspect compliance cues (Caruana, 2024; Caspers et al., 2023). Monitoring committees and feedback loops: schools can institutionalize a grass roots compliance team with a simple checklist and spot checks on a regular basis with feedback to vendors and staff. Lightweight monitoring helps to support fidelity of implementation without adding levels of reporting that are too time-consuming (Fixsen et al., 2005; Durlak & DuPre, 2008). Link campaigns to measurable operational routines: awareness actions should be explicitly linked to observable routines e.g. bin checking, segregation audits and canteen compliance logs etc. This turns participation into the performance of implementation and approves continuous circles of improvement (Fullan, 2007; Ballegeer et al., 2024). Equity sensitive implementation design Functions such as leaders raising the concern of affordability means that the implementation of such reusable transitions should be phased in, and supported through vendor pricing rules, deposit return options, or school-supported alternatives. Equity design mitigates against the risk of sustainability providing a cost-shifting exercise for families (Caspers et al., 2023; Li et al., 2023).

6.5. Limitations and future research

This study is relying on institution-level reporting and structured tools, which are subject to social desirability and variation in their interpretation. Future work can reinforce validity by periodic waste audits, spot observations and triangulation with downstream waste collection records consistent with audit-based approaches as used in campus waste studies (Recycling Assessment and Intervention on a Campus, n.d.). Second, the results are descriptive and integrated in an interpretive manner, which means future studies can try to test specific interventions such as bin-placement optimization or enforcement of the canteen vendor clause using quasi-experimental designs, suggested by intervention-oriented recycling research and bin placement studies (Olapegba, 2025; Boonchieng et al., 2023). Third, SDG and climate linkages are conceptualized as linkages rather than measurable outcomes and diversion rates, shifts in procurement levels and lifecycle impacts of reusable systems can be quantified in future studies in local operating conditions, which is important as benefits arising from reuse depend on cycles of return and reuse (Caspers et al., 2023; Gao et al., 2025). Finally, comparative analyses of cross country differences in staff salary complexity, access to resources, and levels of FTEs in each of the institution types and levels of resourcing within FDE may make clear the conceptual role of such structural or managerial constraints, complementing principal-focused work on sustainability implementation research that finds that aspiration often outpaces systemic embedding (Holst et al., 2025; Borg, 2025).

7. Conclusion

This study was conducted to assess the zero-waste culture and plastic reduction practices in FDE institutions using Islamabad, parallel mixed method design which included institutional practice indicators (N=314) along with leadership interviews (n=20). The results demonstrate a definite pattern of implementation. Norm-based actions which schools can manage within the school are well established, such as paper minimization (97%) and awareness campaigns (87%). Bag related avoidance practices are also relatively strong which suggests that behaviors with household familiarity diffuse more easily into school routines. However, system dependent practices are still inconsistent. Only half of the institutions have segregated bins for important waste streams (50%), student engagement in sorting is moderate (57%) and adoption of canteen-based reusables is low (25%). The qualitative findings explanatory for such gaps

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ISSN P: 3006-1458
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are issues within governance and system design - that the governing practices of canteens (i.e., dependencies on compliance from vendors and defaults during procurement) - and segregation (i.e., dependencies on standardized infrastructure, clear responsibilities, routine monitoring) - are persistent. Overall, the evidence makes SDG 12 one of the best alignments since the observed practices and proposed strategies relate directly to waste prevention, waste reduction, waste reuse and waste segregation. Broader SDG and climate linkages can be understood most by plausible pathways and dependent upon the consistency of Canteen reform, as well as segregation systems.

8. Actionable recommendations

1. Reforming the working of canteens through impose able vendor clauses - enforceable clauses regarding defaults to using reusable serving, restriction on the use of high waste packaging, the definition of compliance check.
2. Unify the minimal possible segregation regime throughout FDE: define types of bins, names and location rules in busy spaces, backed up by straightforward algorithms on behalf of staff and students.
3. Create a light monitoring and feedback mechanism - a monitoring checklist and brief compliance dashboard delivered on a monthly basis, which is associated with corrective actions rather than a piece of paper.
4. Ties campaign to measurable operational actions-ensure that campaigns activate certain routines (segregation drives, compliance weeks in canteen) also include follow up actions.
5. Use equity-sensitive phasing: select low-cost alternatives first, pilot reusable where feasibility is highest, and scale using evidence from implementation performance.

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Appendix A

Instruments (A1–A5 Consolidated)

Study title: Zero-Waste Culture and Single-Use Plastic Reduction in FDE Schools and Colleges, Islamabad: A Mixed-Methods Assessment with SDG and Climate Linkages.

Purpose (for respondents): This study examines current zero-waste practices, constraints, and feasible strategies for reducing single-use plastics. Participation is voluntary; responses are confidential and reported in aggregate.

Recommended respondents: Head/principal, canteen focal person, and one support staff member for waste-handling questions.

A1. School Profile and Zero-Waste Infrastructure Checklist

Mode: Observation and record review

Completed by: Researcher (with head or focal person)

Estimated time: 15 to 25 minutes

Questionnaire

A1.1 Institution profile

1. **Institution type:** Primary / Middle / Secondary / Higher Secondary / College
2. **Location:** Islamabad (Sector/Zone) _____
3. **Total enrollment:** _____
4. **Number of teachers:** _____
5. **Canteen available:** Yes / No
6. **Drinking water source:** Filtered / Cooler / Bottled / Other: _____
7. **Waste collection arrangement:** Municipal / Private contractor / Informal picker / Other: _____
8. **Waste pickup frequency:** Daily / 2–3 times per week / Weekly / Irregular / Unknown

A1.2 Infrastructure and systems

1. Response options (tick one per item): Yes / No / Partly / Not observed
2. Separate bins for at least two waste streams (for example, recyclables and general waste).
3. Bins are labeled with text and/or pictures.
4. Bins are placed at high-use points (canteen, corridors, near classes).
5. Designated temporary storage point for waste before pickup exists.
6. Staff are assigned for bin monitoring/cleaning.
7. Written SOP or policy for waste reduction/segregation exists.
8. A "green committee" or focal team exists for environment/waste.
9. Awareness activities are visible (posters, announcements, student clubs).
10. Evidence of paper-saving practices (double-sided printing policy, reuse of paper).
11. Evidence of reuse practices (reuse of books, uniform drives, repair or reuse of materials).
12. Evidence of organic waste handling (compost pit/bin or garden use): Yes / No / Not applicable.
13. E-waste handling approach exists (batteries, electronics): Yes / No / Not applicable.

A1.3 Quick visual bin check (contamination spot check)

Instruction: Pick two bins (one recycling, one general) and check 10 visible items.

- Recycling bin: correct items out of 10: ___/10
- General waste bin: recyclable items incorrectly placed out of 10: ___/10
- Notes (examples observed): _____

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A2. School Leader Questionnaire
Mode: Self-administered or interviewer-assisted
Completed by: Head/principal
Estimated time: 12 to 18 minutes
Response scales used

- **Agreement scale:** 1 Strongly disagree, 2 Disagree, 3 Neutral, 4 Agree, 5 Strongly agree
- **Frequency scale:** 1 Never, 2 Rarely, 3 Sometimes, 4 Often, 5 Always
- **Feasibility scale:** 1 Not feasible, 2 Low, 3 Moderate, 4 High, 5 Very high
- **Impact scale:** 1 Very low, 2 Low, 3 Moderate, 4 High, 5 Very high

A2.1 Current practices (Frequency scale)
How often does your institution do the following?

1. Conducts campaigns or sessions on zero-waste/cleanliness.
2. Encourages students to reduce littering and waste.
3. Practices paper reduction (reuse paper, double-sided print).
4. Uses recycled materials for some school activities (decor, projects).
5. Promotes carrying reusable bottles/lunchboxes.
6. Avoids plastic bags on campus (students and staff).
7. Uses cloth or fabric bags when needed.
8. Separates waste into at least two categories.
9. Coordinates with a recycler or responsible collector for recyclables.

A2.2 Readiness for implementing zero-waste (Agreement scale)
Change commitment

1. We are committed to strengthening a zero-waste culture in our institution.
2. Implementing zero-waste practices is a high priority for us.
3. We are willing to invest effort to sustain zero-waste practices over time.
4. We intend to follow through on zero-waste plans even when challenges arise.

Change efficacy
5. We have the skills and knowledge to implement zero-waste practices effectively.
6. We can coordinate staff and students to carry out zero-waste activities.
7. We can manage practical barriers (time, supervision, compliance) to implement zero-waste.
8. We can allocate or mobilize resources needed for implementation.

Implementation governance
9. Roles and responsibilities for waste management are clear in our institution.
10. We have a monitoring approach (checks, reporting, supervision) for waste practices.
11. We can engage canteen vendors or suppliers to comply with anti-plastic rules.
12. We can work with the local waste collector/recycler to support segregation.

A2.3 Constraints and barriers (Agreement scale)

1. Budget constraints limit our ability to improve waste systems.
2. Vendor or market availability limits alternatives to single-use plastics.
3. Student compliance is difficult to maintain consistently.
4. Staff workload limits monitoring and follow-up.
5. Lack of bins or space reduces feasibility of segregation.
6. Lack of external waste services reduces feasibility of recycling.

A2.4 Single-use plastic strategy prioritization (Feasibility and Impact scales)
Instruction: For each action, rate feasibility and expected impact in your institution.

ISSN E: 3006-1466
ISSN P: 3006-1458
CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
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CONTEMPORARY JOURNAL OF SOCIAL SCIENCE REVIEW
Vol.03 No.04 (2025)

- **Top 3 strategies you recommend (write):**
  1. _____ 2) _____ 3) _____
- **Why these three are best for your institution (2 to 3 lines):** _____

A3. Waste Quantification Form (Simple Waste Audit)
Mode: Simple audit (sorting and weighing)
Completed by: Researcher with staff support
Estimated time: 30 to 60 minutes per audit; recommended 2 audits on different days
Instructions (brief): Collect waste from a defined area and time window, sort into categories, and weigh using a scale. Record weights in kilograms and note contamination issues (frequently misplaced items).
Audit metadata

- Date: _____ Start time: _____ End time: _____
- Area covered: Canteen / Classrooms / Corridor / Whole school (select one)
- Number of students present that day: _____

Waste categories (weights in kg): _____
Notes on contamination: _____
A4. SDG and Climate Linkage Mapping Matrix
Completed by: Researcher (using evidence from A1 to A3 and interviews)
Purpose: Transparent mapping from observed practices and strategies to SDGs and climate pathways.
Suggested matrix fields (to complete during analysis):

1. Practice/strategy (from A1, A2, A3, A5)
2. Primary SDG linkage (SDG 12 as primary where applicable; others as pathways)
3. Mechanism (how the practice plausibly contributes)
4. Evidence source (A1 observation; A2 indicator; A3 audit; A5 theme)
5. Strength of linkage (High/Moderate/Low; qualitative judgment, justified)

A5. Semi-Structured Interview Guide for School Heads
Mode: Semi-structured interview **Completed by:** Researcher
Estimated time: 25 to 40 minutes **Recording:** With permission only
Core questions (ask all)

1. How do you define “zero-waste culture” in the context of your institution?
2. What zero-waste practices are currently implemented here, and which ones work best?
3. What are the main barriers to implementing stronger waste segregation and reduction?
4. What enables success here (leadership support, student roles, staff routines, community)?
5. Describe how waste moves from classrooms/canteen to final disposal. Who is involved at each step?
6. Single-use plastics: What items are most common in your school waste (bags, bottles, wrappers, cups)?
7. Which strategies to reduce single-use plastic are most feasible here, and why?
8. How do you ensure compliance, especially with canteen vendors and students?
9. What evidence would convince you that the zero-waste program is successful (for example, fewer bags, cleaner areas, audit numbers)?
10. SDG and climate linkages: Which SDGs do you think your actions support, and through what practical mechanism?

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Probes

- **Policy probe:** Is there a written policy or SOP? Who drafted it and how is it enforced?
- **Equity probe:** Do any rules create burden for low-income students? How can you avoid that?
- **Sustainability probe:** What happens after initial campaigns? How do you keep it running?
- **Partnerships probe:** Any coordination with local administration, recyclers, NGOs?