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Occupational Risk and Students' Perceptions of Solid Waste Handling at the South Campus of the University of Education, Winneba

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Abstract: Solid-waste handling in university settings may expose sanitation workers to occupational hazards while leaving the nature of their work largely outside students' awareness. This study explored sanitation workers' accounts of occupational hazards and students' perceptions of waste handling at the South Campus of the University of Education, Winneba, Ghana. A mixed-methods case study combined an audit of 115 accessible waste receptacles with two focus group discussions involving six undergraduate students and four sanitation workers. The audit identified 44 light-duty and 71 heavy-duty receptacles. Residential halls contained 62 receptacles, representing 53.9% of the audited total, and none of the audited receptacles was labelled or colour-coded to indicate a waste-separation function. A supplementary chi-square analysis of receptacle class by aggregated zone type produced χ^2 (2, N = 115) = 8.22, p = .016, with Cramér's V = .27. Because the audit covered the accessible receptacles on one campus, this result is treated as a model-based description of the observed allocation, not as evidence that can be generalised to other campuses. The qualitative analysis generated three themes: exposure without protection; work that is seen but not counted; and distance and its moral cost. Participants described mixed waste containing potentially hazardous materials, inconsistent access to protective equipment, largely informal training, and no formal incident-reporting procedure known to them. Student accounts indicated limited consideration of the conditions under which waste is handled, while workers described limited involvement in operational decisions. The study proposes occupational invisibility as an analytical concept linking temporal separation, limited recognition of occupational risk, and the exclusion of workers' knowledge. The findings suggest that occupational safety and student learning should be addressed together through source separation, task-appropriate equipment, formal training, incident reporting, worker participation in planning, and curriculum-based learning. The findings are exploratory and are not statistically generalisable beyond the study setting.

Keywords: *Occupational Risk, Student Perceptions, Sanitation Workers, Campus Sustainability*.

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I. INTRODUCTION

Research on waste in universities has commonly quantified generation rates, characterised waste composition, estimated recovery potential, and recommended technical improvements (Ugwu *et al.*, 2020). These studies have established campus waste as an important topic in sustainability research. However, fewer studies examine who handles the waste, the conditions under which it is handled, and what students understand about this work. The literature is therefore comparatively limited in its accounts of the people who manage the waste stream (Dery *et al.*, 2018; Millanzi *et al.*, 2023).

Waste handling is physically demanding and socially marginalized, while the labour involved may remain organisationally invisible (Rodríguez-Guerreiro *et al.*, 2024; Starovoytova, 2018). Collection may occur early in the

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morning or at the margins of the academic day, so campus users may encounter the results of work rather than the work itself. The employment arrangements of the sanitation workers who participated in this study were not documented; therefore, no conclusion is drawn about whether they were directly employed by the university or engaged through a contractor. Although sanitation workers are present on the campus daily, their experiences may receive limited attention in the documents and decisions through which institutions organize their operations.

The problem persists in institutions that train teachers and environmental educators. If students learn about waste only as a technical problem to be solved by systems, they may graduate without understanding the labour that makes those systems work (Aragaw *et al*., 2016). Derdera & Ogato (2023) argue that students may also graduate without recognizing the occupational justice dimensions of waste management alongside its environmental and engineering concerns. Therefore, a university's silence about its own waste work is part of the curriculum taught implicitly and learned thoroughly (Ratnaningrum *et al*., 2024).

This study had three objectives: (1) to describe the occupational hazards reported by sanitation workers during campus waste handling; (2) to examine students' perceptions of waste handling and the people who perform it; and (3) to consider what the relationship between campus operations and these perspectives may imply for teaching and learning.

Earlier studies examined hygienic and safety waste management practices in institutions (Bailey *et al*., 2015; Cooper, 2008). The present study builds on that work rather than claiming that occupational safety among sanitation workers has not previously been investigated. It adds an audit of campus waste receptacles and students' perspectives to examine how infrastructure, workers' accounts, and campus learning intersect. The study proposes occupational invisibility as an analytical concept describing a condition in which occupational risks may remain insufficiently recognized while the practical knowledge of the workers exposed to them is excluded from decisions affecting their work. By considering the infrastructure audit alongside workers' accounts and students' perceptions, the study examines these dimensions in a single campus setting. The concept is proposed as a framework for further investigation, rather than as a validated measure.

This study differs from previous work on the same campus, which mainly measured waste composition and energy-recovery potential (Gesuli-Saliba *et al*., 2026). It focuses not on the waste stream, but on the people who move it and students who pass by it. In this article, "sanitation workers" refers to the participants who collect, lift, or transport waste. the codes H1-H4 identify the four sanitation-worker participants, while L1-L6 identify the six student participants.

II. MATERIALS AND METHODS

➢ *Study Setting*

The study was conducted at the South Campus of the University of Education, Winneba, in Ghana's Central Region. It is situated along the Accra Cape Coast highway at approximately 5°20′N and 0°37′W and covers about 0.65 km². It has five halls of residence (Ghartey Halls A, B and C; Aggrey Halls A and B), the Faculty of Science Education, the Faculty of Foreign Languages, administrative offices, canteens and open recreational space.

Waste collection is performed by sanitation staff working under the university's environmental health structures. Materials are deposited in communal receptacles and sent to municipal disposal sites. The research team did not have access to the documented campus waste quantities, policy, and no formal recycling partnership was established during the study period.

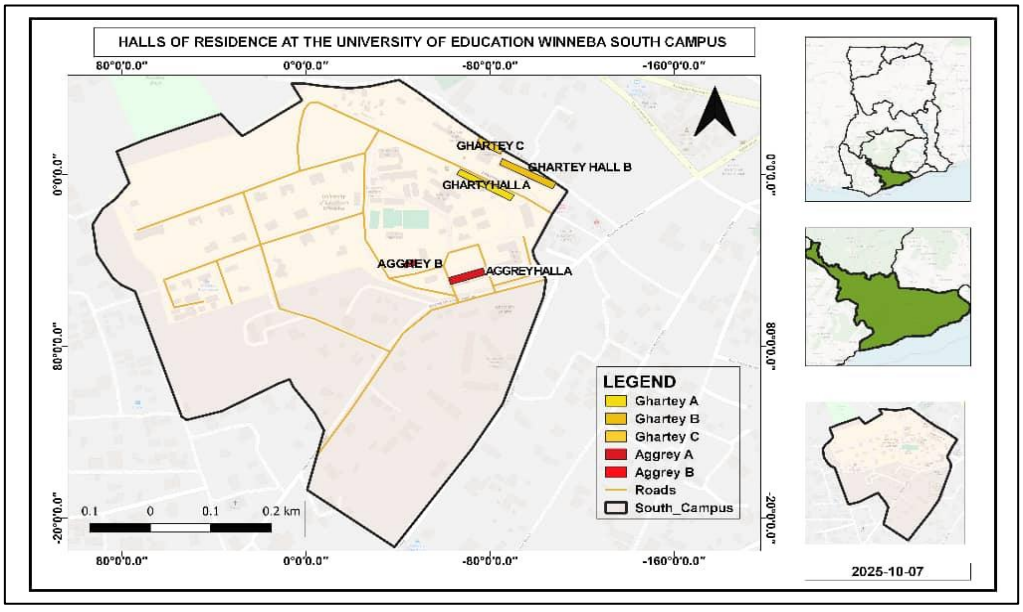


Fig 1 Map of UEW South Campus Showing the Sampling Locations

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➢ *Research Design*

The study used a mixed-methods case-study design that combined an infrastructure audit with qualitative focus group discussions. The audit documented the physical arrangements within which waste handling occurred, including receptacle type, condition, and the presence or absence of source separation information. The focus group discussions explored workers' accounts of those arrangements and students' understanding of the work (Cavallin *et al*., 2020; Philomena, 2024). The audit findings and participant accounts were compared during interpretation to identify areas of convergence and complementarity. The design was exploratory and was not intended to generate prevalence estimates (Munawir *et al*., 2020; Roman *et al*., 2025).

➢ *Infrastructure Audit*

All accessible waste receptacles on the South Campus were audited over five consecutive weekdays during the February–April 2025 fieldwork period, between 08:00 am and 16:00 pm. For each receptacle, the audit recorded its zone, material type, estimated capacity, physical condition, presence or absence of a lid, presence or absence of colour coding or labels indicating a separation function, and location.

For this audit, receptacles were classified as light-duty or heavy-duty using their observed material, estimated capacity, and typical location. Light-duty receptacles were polypropylene or low-density polyethylene containers, usually 10–50 L in capacity and used indoors. Heavy-duty receptacles were high-density polyethylene, polyvinyl chloride, or composite containers, usually 120–360 L in capacity and used outdoors or in communal areas (Cavallin *et al*., 2020). A total of 115 accessible receptacles were recorded. Photographs were taken at representative collection points to support verification of the field records. These capacity ranges are operational definitions used for this study, not universal classification standards.



Fig 2 Sample of Light-Duty Waste Receptacles at the South Campus of UEW


Fig 3 Sample of Heavy-Duty Waste Receptacles at the South Campus of UEW

➢ *Focus Group Discussions*

Two focus group discussions were conducted between February and April 2025, involving ten participants: six undergraduate students and four sanitation workers. The students were drawn from Levels 200–400 and represented all five halls of residence; three were male and three were female. The sanitation workers included waste collectors and sweepers with three to ten years of service; two were male and two were female. Each discussion lasted between 30 and 50 minutes and took place in a vacant seminar room away from supervisory staff workers (Saad *et al*., 2025; Swain, 2013).

The discussions were intended to capture the perspectives of students and sanitation workers on the same campus waste handling system. However, given the small number of sessions, the findings were interpreted as exploratory rather than as definitive evidence of thematic saturation (Roman *et al*., 2025). The analysis therefore focuses on the themes supported by the available participant accounts and observational evidence. The student and sanitation worker discussions were held separately, with one group for each participant category.

A semi-structured discussion guide covered the following areas: daily handling practices and perceived hazards; access to protective equipment, training, and reporting procedures; students' observations of waste work and their understanding of what it involves; and suggestions for improvement from both groups. Sessions were audio-recorded with participant consent, and the full guide is available from the corresponding author upon request (Yukalang *et al*., 2017). The sessions were conducted in English and Fante for better understanding and interpretation. Contributions made in Fante were translated during transcription and verified by a second speaker of the language.

Participant accounts are presented in the results section as reported speech rather than verbatim quotations. The approach was used because the sanitation-worker group was small and distinctive wording could make participants recognisable. The summaries convey the substance of

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participants' accounts without reproducing their exact words. The transcripts are stored securely and should be shared with reviewers only where confidentiality can be protected.

➢ *Data Analysis*

The transcripts were analysed thematically using six phases: familiarisation with the data, initial coding, generating candidate themes, reviewing themes, defining and naming themes, and producing the report (Werkmeister *et al*., 2024; Yukalang *et al*., 2017). Coding combined deductive categories informed by occupational health and safety and the sociology of dirty work with inductive categories developed from participants' accounts. Coding combined deductive categories from the literature on occupational health and safety and the sociology of dirty work with inductive categories based on participant accounts. Analytic memos tracked interpretive decisions throughout.

One analytic decision deserves to be commented on. Early coding generated a larger set of candidate themes, many of which overlapped far too strongly. Rather than keeping them separately, we consolidated them into three central themes, each with its own internal differences. The consolidation enhanced the explanation, allowing for a more comprehensive development of all themes compared to maintaining them in an extended list (Irlam *et al*., 2024).

Student data required a different strategy. Accounts were read first for what they said about waste work and then for what they did not say. Silences were as informative as statements. Students spoke easily about workers and with equal eagerness to let you know they had never considered what the work involved. Reading absence allowed occupational invisibility to be constructed from the data rather than imposed on it (Starovoytova & Namango, 2018a).

The audit enumerated all accessible receptacles meeting the study criteria, rather than selecting a sample. The counts and percentages therefore describe the audited receptacle stock during the observation period, although inaccessible, informal, or temporary receptacles may not have been captured. As a supplementary diagnostic, a chi-square test compared the observed allocation of receptacle classes across aggregated zone types with the expected allocation under a null model of independence between zone type and receptacle class. A likelihood-ratio statistic was also calculated. The reported p-values are model-based diagnostics of the observed allocation and should not be interpreted as estimates of sampling uncertainty or generalised to other campuses. A combined 3 × 2 table was used for the primary analysis so that all expected counts exceeded five; a disaggregated 4 × 2 table was examined as a sensitivity analysis. Observed counts, expected counts, and Pearson residuals are reported in Table 3.

The analysis was performed by a single coder. Given the small sample size and exploratory goal of the study, double coding was not performed, and the thematic picture should be interpreted as interpretive and not as an inter-rater measurement. Trustworthiness was confirmed through verbatim transcription, triangulation of worker accounts, student accounts, and observational data, and peer debriefing among the research team. The study does not claim statistical generalizability. Its claims are analytical and applicable to similar institutional environments.

➢ *Limitations*

The study is limited to one campus and only ten focus group participants, four of whom were workers. The worker sample is small, and the responses should be taken as indicative rather than representative. The diverse nature of the groups may have restricted what workers were comfortable saying to students in front of them, although sessions were conducted away from supervisory staff and facilitation was done to balance contributions. First-year students were not included, and their views may differ because they have had less exposure to the campus waste system. The study did not record whether workers were directly employed by the university or engaged through a contractor, which makes this difference important to accountability and should be considered in future work. The audit records the conditions on the days of the observation and does not capture informal or temporary receptacles. Since the audit enumerated the campus rather than sampling it, the chi-square results on patterns of behaviour at the South Campus cannot be generalized to other campuses; comparable audits at other campuses would have to be done before any wider claim could be made. Coding was done by a single analyst, and the thematic account is an interpretive construct and not an inter-rater measurement. Finally, the study is about student perceptions at a single point and does not test if they change when problems are brought to their attention.

➢ *Ethical Considerations*

Permission to observe the collection points was obtained from the relevant university offices. The study was reviewed by the department, and all participants received an information sheet explaining the purpose of the study before giving written or oral consent. They were told that participation was voluntary and that they could withdraw at any time. No identifying information was retained in the transcripts or reporting, and accounts were attributed only to role-based codes. Because workers were asked about conditions that could be read as criticism of their employer, sessions were held away from supervisory staff.

III. RESULTS AND DISCUSSIONS

The results are presented in three linked parts: the infrastructure audit and distribution of receptacle classes, the three themes developed from the focus group discussion and a synthesis of the findings through the proposed concept of occupational invisibility and its implications for campus practice and environmental education. The quantitative findings describe the audited receptacles stock, while the qualitative findings illustrate participants' report experiences and perceptions.

➢ *The Material Conditions of Handling*

The audit identified 115 waste receptacles on the South Campus as shown in Table 1. Heavy-duty bins accounted for 71 units (61.7%), and light-duty bins accounted for 44 units

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(38.3%). Residential halls held 62 bins, amounting to (53.9%) of the campus stock, although the number of bins varied from 19 in Ghartey Hall A to 10 each in Ghartey Hall B and Aggrey Hall B. Teaching areas held 18 bins, offices 8, canteens 9, and open spaces 18 (Table 1). Table 2 further summarizes the two receptacle classes.

Three features of this stock are directly related to its handling. First, no receptacle on campus was color-coded, labelled, or otherwise separated according to source. All bins were visually identical, regardless of their location and the waste they were likely to receive. Second, 44 receptacles were light-duty units; some were cracked, lidless, or too small to accommodate the required volume. Third, the provisions for offices and teaching areas were uneven and less adequate those of residential halls.

The absence of colour coding or labels is important because receptacles can provide users with practical instructions about how waste should be separated. On the audited campus, the receptacles did not visibly indicate separate disposal streams. This finding suggests that the existing infrastructure did not give users clear guidance on source separation. The audit does not , by itself establish the intentions of the staff responsible for procurement of waste management policy, but it does show that the receptacles available during the observation period did not communicate a separation function (Ojuri *et al.*, 2024).

The second feature adds to the first. Light-duty receptacles are appropriate for offices and classrooms, where waste volumes are small and the waste itself is fairly homogeneous. They are not appropriate for corridors and stairwells in residential areas, where food waste, packaging, and sometimes broken items are discarded (Muniu *et al*., 2017). Many of the units I observed were cracked or lacked lids, which was a problem for two reasons. An open, lidless bin can absorb rainwater and produce leachate and odour, and is accessible to vectors. It also makes the eventual lifting of the bag wetter, heavier, and more hazardous than it would otherwise be. The condition of the receptacle thus directly enters the exposure profile of the worker who collects it.

The offices and lecture halls together contained 26 receptacles, representing 22.6% of the audited stock. The audited did not measure waste generalization by zone, therefore the number of receptacles alone cannot establish whether these areas were adequately served or whether waste was more likely to be left outside bins (Syafrudin *et al*., 2023). These questions would require zone-specific waste quantities, observations of overflow or records of collection frequency. Nevertheless, the distribution indicates that the campus used different receptacles classes and quantities across residential, teaching, administrative and communal areas (Helelo *et al*., 2019; Starovoytova, 2018).

These observations questioned procurement logic The presence of heavy-duty receptacles suggests that decisions have been made regarding durability and capacity, which is a reasonable response to the increasingly visible problem of overflowing bins in residential halls (Hanedar *et al*., 2021). Dery *et al*., (2018), argued strongly that waste bin durability and capacity deal with collection, not handling. A robust bin that takes mixed waste is still a bin that produces hazardous bags. The procurement logic is incomplete: it has solved where to put waste but not what happens to it, and the cost of that incompleteness is disproportionately borne by the people who lift the bags.

Table 1 Distribution of Waste Receptacles by Zones and Class

Zone	Light-Duty Receptacles	Heavy-Duty Receptacles	Total
Ghartey Hall A	05	14	19
Ghartey Hall B	03	07	10
Ghartey Hall C	04	07	11
Aggrey Hall A	02	10	12
Aggrey Hall B	04	06	10
Lecture Halls	10	08	18
Offices	06	02	08
Canteen	03	06	09
Open Spaces	07	11	18
Total	**44**	**71**	**115**

Source: Data from the field audit, 2025

Table 2 Capacity and Classes of Receptacles

Class	Typical capacity	Common locations (zones)
Light-duty	10 - 50 L	Offices, lecture halls, corridors
Heavy-duty	120 – 360 L	Halls, canteens open spaces

Source: Data from the field audit, 2025

➢ *Patterning of Receptacle Class Across Zones*

Table 1 shows that the receptacle class was unevenly distributed among campus areas. Residential halls, which held the largest share of the campus stock, carried the majority of heavy-duty units, while academic and administrative areas were mainly served by small indoor bins. To test whether this distribution was proportional, we conducted a chi-square test of association on the combined categories shown in Table 3.

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The academic and administrative zones were combined because the administrative cell would have been below the minimum expected count. Communal and service zones comprise of canteens and open spaces. All expected counts are greater than five; the minimum is 9.95. Cells with |SR| ≥ 1.5 are in bold. Pearson χ^2 (2, N = 115) = 8.22, p = .016, Cramér's V = 0.27; likelihood ratio G^2 (2, N = 115) = 8.08, p = .018; Monte Carlo p = .016 (10,000 permutations).

The association was statistically significant, χ^2 (2, N = 115) = 8.22, p = 0.016, Cramér's V = .27, showed a small-to-moderate association between zone type and receptacle type. A likelihood ratio test also yielded a similar result, G^2 (2, N = 115) = 8.08, p = .018. The audit covered the campus but did not sample it; therefore, we also ran a Monte Carlo test with 10,000 permutations to get a better sense of how unusual this allocation was compared with all possible allocations of 44 light-duty and 71 heavy-duty receptacles in zones of this size; it returned a comparable value, p = .016.

Table 3 shows that the combined academic and administrative category had more light-duty receptacles than expected (observed = 16; expected = 9.95; Pearson residual = 1.92) and fewer heavy-duty receptacles than expected (observed = 10; expected = 16.05; Pearson residual = −1.51). The residential category showed smaller deviations from expected counts, while the communal and service category was close to the expected distribution. These residuals describe the cells in the combined contingency table; they should not be attributed to academic and administrative areas separately.

A disaggregated 4 × 2 table dividing academic areas into administrative and communal and service areas into a fourth category produced a consistent result, χ^2 (3, N = 115) = 9.10, p = .028, Cramér's V = .28. Only two out of its eight expected counts dropped below five, 3.06 and 4.94 in the administrative row; thus, the result should be read with that caveat. The combined 3 × 2 table is the primary test because all its expected counts are higher than five and the combination is determined by the size of the administrative cell, not by the result.

There are three interpretive points. The first is substantive and concerns what the pattern says about institutional priorities (Ebrahimi & North, 2017). The heavy-duty capacity in residential halls reflects where waste volumes are most concentrated and is a logical response to the collection problem. However, this also means that the zones with the most mixed waste are served by containers unable to separate it, while the zones with proportionally more light-duty bins have little volume at all (Asare *et al*., 2022). The campus is designed to remove waste and not sort it, and the statistical pattern is an illustration of this design choice (Gunamantha, 2016). The pattern is not an accident of procurement; it is the trace of a set of decisions that treated waste as a volume problem rather than as a material and occupational one.

The second point concerns the academic and administrative areas in particular. The excessive number of light-duty bins in offices and teaching areas suggests an implicit notion about what waste is generated in those spaces: paper, packaging, a few food containers, but nothing that requires a container of that scale. This may also be true for offices (Kaushal *et al*., 2012). However, this does not hold true for teaching areas, where students eat and drink between lectures, while windowsills and stairwells are used for disposal because adequate space is unavailable. Therefore, the light-duty bin is not just an undersized box. It is an assumption about the waste stream that does not survive contact with how the space is actually used.

The third point is methodological in nature. Because the audit was a census, the test describes patterning within the campus but not an estimate of a parameter for a wider population of universities (Leal Filho *et al*., 2024). It is a measure of the strength and location of the departure and does not support claims about Ghanaian higher education as a whole. The Monte Carlo result is published for this reason: it asks how unusual the observed allocation is against the universe of allocations permitted by the marginals, which is the right question for an enumerated population. Readers who want to draw wider conclusions can do so, but the inference is theirs, not the study's.

Table 3 Observed and Expected Frequencies and Standardised Residuals for Receptacles Class by Zone Type

Zone type	Light-duty *n*	Light-duty E	Light-duty SR	Heavy-duty *n*	Heavy-duty E	Heavy-duty SR	Total
Residential	18	23.72	-1.17	44	38.28	0.92	**62**
Academic and administrative	16	9.95	1.92	10	16.05	-1.51	**26**
Communal and service	10	10.33	-0.10	17	16.67	0.08	**27**
Total	**44**	**44.00**		**71**	**71.00**		**115**

Source: Data from the field audit, 2025

- Note: n = observed frequency; E = expected frequency; Pearson residual = (observed frequency − expected frequency)/ √(expected frequency).

➢ *Theme One: Exposure Without Protection*

The first theme concerns the hazards workers encounter and the arrangements or lack thereof, intended to manage them. Exposure is routine, recognized by workers, and largely unmanaged by the institution. The theme was structured around four dimensions of exposure, all of which appear in

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the participants' accounts and are made more likely by the material conditions described in the audit.

The workers exhibited a consistent exposure profile. They described broken glass, needles, and electronic fragments inside bags of food waste, and because waste arrived unsorted, there was no point at which such items could be intercepted before the waste was handled manually. One worker traced the hazard to the moment of its generation.

Participant H1 described waste as arriving in mixed bags containing food, bottles, paper, and other items. The participant identified glass and electronic fragments within food waste as hazards that required careful handling.

Another worker made the connection between separation and safety more directly.

Participant H4 reported finding broken bottles and needles in mixed waste and said that handling such material without adequate hand protection created a risk of injury. The participant considered source separation a way to make the work safe.

A third participant described how the physical state of the containers compounded the risk, particularly after rain.

Participant H3 explained that lidless receptacles could leave waste wet after rainfall, making bags heavier and more difficult to lift. The participant also expressed concern about contact with liquid leaking from the waste.

Participants described encountering electronic fragments in mixed waste. Such items may present sharp-edge or hazardous-substance concerns, but this study did not measure chemical exposure or establish the frequency or severity of any resulting health effects (Olanrewaju *et al*., 2019)

The second is biological exposure through contact with putrescible material, leachate, and vectors at overflowing bins. This hazard is less obvious than the first, but no less serious. Food waste in a tropical climate decomposes rapidly, and the liquid that accumulates in a bin without a lid is a medium for bacteria and a breeding ground for flies (Malakahmad *et al*., 2010). Workers who lift such bags are exposed through the skin and through inhalation, and the risk increases with the amount of time the waste has been sitting. In the next theme, overflow is not only an aesthetic problem. It is an exposure multiplier.

The third component is ergonomic strain from lifting heavy, unsealed, and sometimes wet bags. This is probably the least discussed issue in the waste management literature and the most taken for granted by workers themselves (Igibah *et al.*, 2019). A bag of food waste that has absorbed rainwater weighs considerably more than a dry bag in dry conditions and has to be lifted from a receptacle with a capacity of 120 to 360 litres to a collection vehicle. The strain is cumulative and is not recorded anywhere because no system exists to record it. The fourth component is chemical and electronic exposure from batteries and electronic fragments entering the general stream. This is the least frequent but most serious in individual cases, as batteries can leak and electronic items can have sharp edges and hazardous materials (Mengistie & Ray, 2025).

Protective arrangements were described as inconsistent. Workers reported having gloves, boots, and aprons, but the equipment was not always available or well suited to the job. Gloves used for general cleaning were not always appropriate for handling sharp items. This inconsistency is worth considering because it confirms a certain institutional logic. There is equipment, so the institution knows that handling is risky (Ratnaningrum *et al*., 2024). However, the equipment is not reliably provided, so recognition does not translate into a standing entitlement. The worker who receives gloves on one round but not the next learns that protection is discretionary rather than guaranteed and adapts accordingly by treating exposure as normal.

Training was largely experiential. Workers reported no structured instruction about sharps, handling hazardous items, or responding to exposure incidents, and their knowledge came from experience and informal advice passed on among colleagues. Experiential learning in a dangerous environment has a particular quality: it teaches through injury and near-miss rather than through instruction, and it normalises the hazard that produced the lesson. A worker who has learned to check bags for glass by feel has learned something useful, but the learning has been purchased with the risk of a cut and the lesson carries the implicit message that cuts are part of the job.

Participants described supervision primarily in terms of completing collection rounds and did not describe a formal procedure for reporting injuries or near-misses. This does not establish that no reporting system existed; rather, it indicates that a formal procedure was not identified in the accounts gathered for this study. Without a clear and trusted process for recording incidents, the institution may have difficulty identifying recurring hazards and deciding where preventive action is needed. The findings therefore point to the need to clarify reporting arrangements and ensure that workers know how to report injuries and near-misses (Potiracha & Baars, 2026).

This finding is important because it shows that the problem lies in the design of the system and not in worker behaviour. The workers in this study were not careless. They were experienced, they knew the risks, and they had adapted their practice accordingly. What they lacked was a system to remove the hazard or record its effects. Safety-climate research consistently shows that outcomes depend less on individual attitudes and more on management commitment, communication, and the importance of safety in operational decisions (Etim *et al*., 2025; O. M. Owojori *et al*., 2022). At the South Campus, safety was not absent from institutional intention, but it was not integrated into the design of the waste system. The intention is visible in the presence of gloves; the absence of integration is visible in their irregular provision and in the absence of reporting.

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The occupational health literature on waste workers is an interesting comparison. Studies in high-income contexts have documented a higher incidence of musculoskeletal injury, respiratory complaints, and sharps-related infection among collection workers and attributed these outcomes to mixed waste streams, the way work is organized, and lack of engineering controls (Munawir *et al*., 2020; Sarpong *et al*., 2019). The South Campus shows that the absence of interaction with surveillance makes these risks invisible. Therefore, the absence of reporting is no small administrative problem. It is the mechanism by which a recognized hazard is side-lined.

- *Theme Two: Work That Is Seen but Not Counted*

The second theme concerns the distinction between workers' visibility and the visibility of their work. Its central claim is that students see sanitation workers every day and know almost nothing about their work. The theme is organized around three dimensions of invisibility: temporal, linguistic, and institutional.

Students could readily describe the physical presence of workers on campus. They could say when collection was happening, which routes were used, and what the workers wore. But when asked what work was actually involved, their accounts became general. One student described the timing that keeps the work out of sight:

Participant L4 explained that collection often took place before students began their day, so students usually encountered emptied receptacles rather than observing the collection work itself.

A second said that the question had simply never come up.

Participant L2 said that the process of emptying receptacles was familiar but that the people performing the work and the conditions they faced had rarely been considered.

A third explained how the absence of visible recycling infrastructure had shaped her sense of what the institution expects.

Participant L1 recalled seeing a recycling message but not separate receptacles, and said that this mismatch made source separation appear to be a practice that the campus did not actively support.

The temporal dimension is the easiest one to identify. Collection starts before the day begins, so students see the results of work and not the work itself. The system actually works in a way that keeps handling out of sight. That is not accidental; it is a normal and practical way to clear bins before the day's waste accumulates. But the effect is that work becomes a background condition of campus life and not an activity that is visible (Aragaw *et al*., 2016; Diggle & Walker, 2022). Students see clean bins and empty spaces, and the labour that produced them is inferred rather than observed.

Students often described waste as something that was emptied or taken away, rather than as material handled by identifiable people. This passive phrasing may reflect the routine language used to describe campus services and does not, on its own, demonstrate indifferences. In the context of this study, however it illustrates how the labour involved in waste collection can remain outside everyday descriptions of campus cleanliness.

The institutional dimension is most important. Sanitation workers described their role as absent from campus planning. Decisions about bin procurement, collection times, and campus cleanliness were made elsewhere, and workers were not consulted about the design of the system with which they work. One worker put it plainly:

Participant H2 reported that suggestions about bin placement had been made but had not resulted in changes, and that sanitation workers were not routinely consulted about these decisions.

This is not simply a matter of consultation for its own sake. Workers have knowledge that planners do not possess: they know which bins overflow first and which routes produce the most dispersed waste, which places generate the most hazardous mixtures, and which times of day produce the heaviest loads (Safo-Adu & Owusu-Adzorah, 2023). That knowledge is fundamental to the design of the system and its absence is a loss to the organization as well as injustice to the workers. The exclusion is also self-reinforcing: the system remains built without the input of the workers because the problems they would solve are not addressed and the workers are not consulted.

This finding is consistent with the sociological literature on dirty work that shows that jobs involved in waste and bodily residue are socially tainted and that workers in such jobs have strategies to maintain dignity in the face of that taint (Starovoytova & Namango, 2018b). The present study adds an institutional dimension. The taint is not only cultural. It is produced and reproduced by organisational arrangements that exclude workers from planning, fails to record their injuries, and schedule their labour outside the hours during which others are present. In other words, the taint is not just a stigma workers carry. It is a set of institutional practices that keep workers at a distance from the rest of the campus community, and students' passive grammar registers those practices (Iscan & Yagci, 2015).

The temporal, linguistic, and institutional dimensions of invisibility interact. Because collection takes place early, students do not see the work. They do not see what it is, so they describe it in passive terms. If it is described in passive terms, then the workers who do it are not part of the discussion about how it will be organised. And because they do not participate in that conversation, the system continues to be designed in ways that make the work invisible. The invisibility is therefore not a state but a process, and the process reproduces itself through the ordinary function of the campus (Yukalang *et al*., 2017).

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The impact of this process extends to the workers as well. It is unlikely that students who never see handling and never hear it discussed will come to understand waste as a social relation. They learn that waste disappears, not that it has to be moved. That lesson is compatible with an environmental education that treats waste as a technical problem, but it is incompatible with one that treats waste as a matter of labour, risk and justice. The invisibility of the workers is therefore also a limitation on what students can learn.

➢ *Theme Three: Distance and Its Moral Cost*

The third theme concerns how students' distance from waste handling work may shape their understanding of waste as a social and ethical issue. It is organized around three dimensions: the gap between formal instruction and operational knowledge, the influence of peer norms on source separation, and the implications for the preparation of future environmental educators.

Students who had been formally trained in environmental management would be able to explain waste hierarchy principles, recycling processes, and the environmental case for separation. They could not describe the conditions under which waste is handled on their own campus. One student was astonished when told that workers encountered sharps in mixed waste.

Participant L3 reported not having previously considered what happened after a bin was emptied or the manual work required to remove the waste.

This is not a knowledge deficit in the ordinary sense. Students had been taught about the technical aspects of waste management. What they had not been taught was that waste management is also a labour, risk, and justice problem. And waste was addressed in the curriculum as a material flow and not as a social relation. So, the gap is not between knowing and not knowing but between two kinds of knowing, the abstract knowledge of the syllabus and the situated knowledge of the campus (Bui *et al.*, 2022). The first is available to students in lectures. The second is available to workers in their daily rounds. The two knowledges are not in competition, but the organization has arranged itself so that students only encounter the first.

A second student asked what would improve conditions for the workers, and reached first for a downstream remedy.

Participant L5 suggested that improved gloves, boots, and protective clothing could help make waste-handling work safer.

The suggestion is sensible and partial. Better equipment would reduce exposure, but it would not remove the hazard (Philomena, 2024). The hazard is produced upstream by the mix of materials in the bin, and the measure that will address it most directly is separation at source. The worker identified that measure. The student did not. The difference is instructive because it represents the position from which each speaks. The worker experiences the outcome and reasons back to the cause. The student sees the worker as a person in need of protection and reasons toward equipment. The student's reasoning is not wrong, but it is based on the visible end of the chain rather than on the source.

A third student showed the extent to which peer norms determined whether separation was worth attempting at all.

Participant L6 explained that the lack of source separation among peers discouraged individual efforts to separate waste, particularly when no shared system appeared to support the practice.

This account adds another dimension to the issue. The distance from handling is not simply a matter of not knowing what happens to waste after disposal (Jothimani *et al.*, 2021). It is also a matter of not having a social context in which separation is a normal and expected practice. The student who separates alone bears a social cost for no visible return, and the rational response is to stop. The institution could change the calculus by providing infrastructure and making separation a shared expectation, but it has not. The absence of a social context for separation is thus another way in which the institution produces the distance described by the theme.

The reproductive dimension is the most important for an organization that trains environmental educators. The University of Education, Winneba prepares graduates who will teach about waste and sanitation in Ghanaian schools. If their own formation has not included knowledge of waste work as labour, they are unlikely to introduce that understanding to their students (K. DEEPIKAVANI* and M. R. THILAKAM, 2023). The distance repeats itself across generations of teachers, not through explicit teaching but through the same kind of tacit transmission that the students in this study experienced. Waste as a material flow will continue to be discussed in the curriculum, and the labour that creates that flow will be absent from the classroom because it was not present in the formation of the teachers.

The theme also has a more general implication for environmental education. Education for Sustainable Development has always been associated with linking abstract knowledge to lived experience (Olatayo *et al.*, 2022). Our findings show that the campus provides an underused setting for this connection. The waste system is a living reality in environmental management, occupational health, and social justice to which we all have access every day. It is not presently being used as such. Using it, however, would require a major shift in the institution's approach to its operations; it would mean a shift in how it sees its own operation from a support system to a place of learning. The implications of that shift are considered below.

➢ *Occupational Invisibility as An Analytical Concept*

Combined, these themes establish a concept that this study calls occupational invisibility. Occupational invisibility occurs when three conditions are present: the work is physically present but temporally or spatially separated; the risks of the work are ignored by those outside it; and the

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knowledge of those who perform it tends to go unnoticed by those who make decisions about what to do.

Each of these conditions has existed on the South Campus. Collection takes place before the academic day, and the work is done at a later stage. Students know that bins are emptied but not what emptying involves, and the risk is not recognised. Workers are not consulted on bin procurement or collection timetables and are not involved in decision-making.

The concept is difficult to distinguish from others. The literature on invisible labour points out that most work is invisible, not by accident, but because of the way we organise space, time and status, and because invisibility is often attached to work done by those with the least power (Tariq *et al*., 2024). The present idea shares that concern but has a few differences. First, it is limited to the experience of the work, and so the question is not whether work is seen or not, but whether the harm is recognised and acted upon. A worker may be visible but still be occupationally invisible if their injury has not been recorded. Second, it adds the epistemic dimension of excluded knowledge: the workers' understanding of the system being treated as a resource that planning is already discarded. Occupational invisibility, then, is not simply a problem of low visibility. It is a condition in which visibility, risk and voice are combined.

The idea has analytical meaning because it shows why harmful conditions persist without anyone wishing to do so. In this system, there was no one who wanted to expose workers to sharps. The exposure is caused by procurement priorities, collection timing, absence of separation, and failure of a system for reporting. Each decision was reasonable on its own. Together, they create a pattern for which no particular person is held accountable without a particular person because no one can see it. The concept names the pattern and the points where it could be interrupted (Jibril *et al*., 2013).

Occupational invisibility also explains why conventional interventions fail. Training workers to handle hazardous waste more safely addresses individual practice but leaves the hazard in place. Providing protective equipment helps but does not prevent contact with sharps. Increasing student awareness may lead to sympathy without changing conditions (Ahmad *et al*., 2025; Olatunji *et al*., 2019). The concept shifts attention to the design of the system: separation at source, task-appropriate equipment, formal reporting and, crucially, workers in planning. Each of these measures interrupts the pattern at a different point, and together they address the three conditions that constitute occupational invisibility.

The concept may also be relevant to other settings where workers' tasks, occupational risks, and practical knowledge receive limited attention. However, this study examined one campus and cannot establish how often these conditions occur in hospitals, schools or other institutions. Further studies could examine whether the three proposed dimensions are useful in those settings and whether they help identify practical points for improving occupational safety and worker participation.

- *Implications for Campus Governance*

The findings have direct implications for campus governance. The research team did not have access to a written campus waste management policy or a documented incident-reporting procedure during the study period, and the audited receptacles did not display source separation labels. The campus has a physical ability to transport waste and the human capacity to handle it. But it lacks a framework that assigns responsibility, demands performance, and makes harm visible.

A campus waste policy should have occupational safety provisions in addition to environmental objectives. It should require separation at source, specify collection schedules that do not concentrate exposure, provide for task-appropriate protective equipment and formal training, establish an incident reporting system, and create a channel through which workers can contribute to decisions about the system they operate. Reporting should be designed to produce usable data rather than a compliance record, and it should be reviewed with worker participation. A reporting system that workers do not trust will produce silence, and that silence will be interpreted evidence as safety. The system's design of the system is therefore as important as its existence (Masjhoer & Vitrianto, 2024).

The measures are best introduced in sequence. Separation infrastructure and regular collection should be implemented first because they remove the hazard at source and minimize overflow. Incident reporting and formal training should follow because they make residual harm visible and build competence. Curricular integration comes last because it depends on the first two measures being in for students to see the system as a system worth studying. Implementing all three of these measures at once could produce visible activity without lasting change. The sequence is not a statement of priority in principle but a reflection of feasibility in a resource-limited institution. Each step lays the groundwork for the next, and the first step is most directly addressing the exposure described in Theme One.

The governance dimension is inextricably linked to a broader discussion of institutional voids in environmental management, where in which the absence of rules, enforcement, and feedback better explains persistently poor results than resource constraints alone (Munawir *et al*., 2020; Suprapto, 2023). In this case, the void is doubly important: it affects not only worker safety but also student education. The institution's silence about its own waste work is not a neutral absence. It is a set of non-decisions whose impacts are borne by identifiable people and whose pedagogical consequences are borne by the students the institution is designed to educate.

- *Implications for Teaching and Learning*

These findings also have relevance for the curriculum. If students graduate without understanding waste as labour, then their environmental education is incomplete. Campus

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waste work should be incorporated into teaching rather than left as a support service.

Three measures follow. First, the campus should be made a place of study, so that all courses in environmental science, public health, and sanitation education require students to study the campus waste system, interview handlers, and assess exposure risks. Second, occupational health should be integrated into waste management teaching so students understand separation at source as a worker protection measure and not just a recycling prerequisite. Third, structured opportunities should be created for students to observe and reflect on how work is done, whether by going on supervised site visits or by working with the sanitation unit.

These measures would do more than add content. They would transform students' relationship to the system they live in. A student who has examined the campus waste system is less likely to see it as a background service and more likely to view it as a set of decisions with consequences for identifiable people. That shift in perception is a learning process is what the curriculum does not currently deliver.

The measures would also change the relationship between the institution and its workers. A campus that studies its own waste system must ask workers what they know, and asking is the first step toward including them in planning. The pedagogical and the governance implications thus converge: the same measure that would enrich student learning would also begin to address the exclusion documented in Theme Two.

➢ *Comparison with Other Institutions*

These conditions described here are not unique to the University of Education, Winneba. Manual collection, mixed waste and limited protective equipment are common features of institutional waste management across the region (Asare *et al*., 2022; Kuleape, *et al*., 2014). What varies is the level to which institutions make an effort to recognize and deal with them. Those that have improved conditions have generally done so by combining infrastructure change with organisational change. Separation at source reduces contact with sharps. Scheduled collection with weekend coverage reduces overflow (Adeniran *et al*., 2017). Worker participation in planning surfaces problems before they become routine. None of these measures is technically complex. What they require is the recognition that waste work is a safety matter and that the people doing it hold knowledge worth using (Cleveland *et al*., 2025).

The comparison also indicates an evaluative criterion for campus sustainability. More and more institutions are being measured on waste diversion, carbon footprint, and recycling rates (Mbuligwe, 2002; O. Owojori *et al*., 2020). Very little is considered about the safety of those workers who achieve those rates. Adding occupational indicators to campus sustainability assessment would not only reveal a missing element but also a key component. Candidate indicators include the proportion of receptacles that are colour-coded, the rate at which they are collected relative to generation, the availability of appropriate protective equipment, and the existence and use of an incident reporting system, as well as the presence of workers in planning forums (Boahemaa *et al*., 2024; Siles-Castellano *et al*., 2021). Each of these is measurable, and that is to say, each would turn attention to the situation in which waste work is performed.

IV. CONCLUSION

This study examined sanitation workers' reported occupational risks and students' perceptions of waste handling at the South Campus of the University of Education, Winneba. The audit identified 115 accessible receptacles, including 71 heavy-duty and 44 light-duty units, and found that none displayed labels or colour coding for source separation. Focus group participants described mixed waste and reported gaps in protective equipment, structured training, and incident reporting. These accounts indicate potentially hazardous working conditions, but the study did not measure injury rates, clinical outcomes, or actual chemical or biological exposure.

The study proposes occupational invisibility as an analytical framework linking the timing and visibility of waste-handling work, the recognition of occupational risks, and the extent to which workers' practical knowledge is considered in operational decisions. The findings suggest that occupational safety and student learning should be considered together. Source separation, suitable protective equipment, structured training, clear incident-reporting arrangements, and worker participation are practical priorities for campus management. Campus-based teaching activities could also help students connect environmental principles with the labour involved in waste handling. Since the research was exploratory and confined to one campus and ten focus-group participants, the findings should be interpreted within that scope.

➢ *Declarations*

- Conflict of interest: The authors declare that they have no competing interests.
- Funding: This research received no specific grant from any funding agency.
- Ethical approval: All participants were informed about the study and provided written or oral consent before participating.
- Data availability: The infrastructure audit data are available from the corresponding author on reasonable request. Transcripts are not publicly available because they contain information that could identify participants.

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