INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN SOCIAL SCIENCE (IJRISS)
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

Assessing the Socio-Environmental Impacts of Petroleum and Lubricant Spillage: A Case Study of the University of Cape Coast Transport Section, Cape Coast, Ghana

William Kwesi Yaro[1], George Nuer Appertey[2], Kwakye Akwasi Owusu[3*]

[1]Transport Section, University of Cape Coast, Cape Coast, Ghana

[2]Directorate of Consular & General Services, University of Cape Coast, Cape Coast, Ghana

[3]Directorate of Human Resource, University of Cape Coast, Ghana

[*]Corresponding Author

DOI: https://doi.org/10.47772/IJRISS.2026.100800353

Received: 17 August 2026; Accepted: 22 August 2026; Published: 05 September 2026

ABSTRACT

Higher education institutions (HEIs) operate transport systems that support academic, administrative, clinical, and logistical activities, but these operations generate petroleum and lubricant wastes that may pose environmental, occupational, and institutional risks when inadequately managed. This study assessed the socio-environmental impacts of petroleum and lubricant spillages at the Transport Section of the University of Cape Coast (UCC), Cape Coast, Ghana. It explores the frequency and nature of spillages, their ecological consequences, and the social and occupational risks they pose. A mixed-methods case study design was adopted. Data were collected through structured questionnaires administered to 100 staff and semi-structured interviews conducted with 22 additional staff, supplemented by field observations and review of relevant institutional documents. Quantitative data were analysed using descriptive statistics and Pearson correlation analysis, while qualitative data were analysed thematically.

The findings indicated that petroleum and lubricant spillages occurred mainly during vehicle servicing, fueling, lubricant handling, and waste disposal activities. Field observations and participant reports indicated soil contamination, vegetation degradation, potential risks to surface and groundwater resources, and occupational health and safety concerns. Participants also identified fire hazards, reduced workplace safety, and potential reputational implications for the institution. The findings suggest that inadequate containment infrastructure, limited awareness of spill-prevention practices, and weaknesses in waste-management procedures contribute to the persistence of spill-related risks.

The study concludes that petroleum and lubricant spillages constitute an important socio-environmental management challenge within university transport operations. Strengthening spill-prevention measures, staff training, environmental auditing, containment infrastructure, and institutional environmental management policies could reduce associated risks and promote sustainable transport operations. Because no soil or water samples were chemically analysed, environmental impacts were assessed through field observations and stakeholder reports rather than laboratory-confirmed contamination.

Keywords: Petroleum spillage, Lubricant spillage, Environmental impact, Occupational health and safety, Transport management, Higher education institutions, Ghana

Cite This Article: Yaro WK, Appertey GN, Owusu KA., Assessing the Socio-Environmental Impacts of Petroleum and Lubricant Spillage: A Case Study of the University of Cape Coast Transport Section, Cape Coast, Ghana. International Journal of Research and Innovation in Social Science (IJRISS) ISSN No. 2454-6186 | DOI: 10.47772/IJRISS

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

INTRODUCTION

Higher education institutions (HEIs) rely on efficient transport units to support academic, clinical, and administrative operations (Altbach et al., 2019; UNESCO, 2020). These units operate vehicle fleets that consume significant quantities of petroleum products and lubricants, thereby generating waste streams that require careful environmental management (National Research Council, 2003; Monteiro et al., 2020; Kwao-Boateng et al., 2022). Petroleum and lubricant spillages whether accidental or resulting from improper handling during fueling, servicing, or storage—pose substantial risks to ecological and public health systems (Fingas, 2013; Etkin & Nedwed, 2021). Globally, petroleum spills have been associated with soil infertility, groundwater contamination, aquatic ecosystem disruption, and long-term public health concerns due to exposure to hydrocarbons and volatile organic compounds (VOCs) (Fingas, 2013; Michel et al., 2013; National Academy of Sciences, 2015). Lubricants, in particular, often contain persistent heavy metals such as lead, chromium, and zinc, which accumulate in soils and sediments and can exert toxic effects on humans, animals, and vegetation (Thakur & Koul, 2022; Adofo et al., 2022).

In addition to environmental hazards, spillages in institutional settings create occupational and social risks (Abereton et al., 2023; Huynh et al., 2021; Laffon et al., 2016; Sveum et al., 2009). Staff may be exposed to harmful chemicals, increasing the likelihood of respiratory disorders, dermatological irritation, or chronic toxicities (Huynh et al., 2021; Fingas, 2013). The presence of inflammable materials further elevates fire risks, while poor waste handling practices may undermine public confidence in an institution's environmental stewardship (Barker et al., 2020; Etkin & Nedwed, 2021). For universities, which serve as models of scientific knowledge and social responsibility, unmanaged petroleum and lubricant waste can also result in reputational damage and conflict with national environmental standards (UNEP, 2018; Monteiro et al., 2020).

In Ghana, transport operations constitute the backbone of mobility in higher education institutions, yet empirical attention to petroleum and lubricant spillages in university transport units remains limited (Adofo et al., 2022; EPA Ghana, 2020). Research on oil contamination in the Ghanaian context has predominantly focused on marine, artisanal, or industrial settings, leaving a gap concerning HEIs despite their extensive vehicle fleets and maintenance activities (Carls et al., 2004; Michel et al., 2013). Moreover, research in Ghana has demonstrated that petroleum fuels and lubricants can adversely affect soil properties in automobile workshops (Nyarko et al., 2019), while spilled engine oil has also been associated with changes in soil quality and plant performance (Hanyabui et al., 2021). At the University of Cape Coast (UCC), the Transport Section manages a large number of vehicles used for academic outreach, patient transport for clinical units, administrative mobility, and logistics. Given the frequency of servicing and fueling activities, the potential for recurrent petroleum and lubricant spillages is considerable.

This study therefore examines the socio-environmental impacts of petroleum and lubricant spillage within the UCC Transport Section. Specifically, it aims to: (i) determine the extent and nature of spillages occurring within the unit; (ii) assess their environmental and public health consequences; and (iii) propose evidence-based strategies for spill prevention, containment, and mitigation. By addressing a neglected area of environmental health research in HEIs, the study contributes to improving institutional compliance, occupational safety, and ecological sustainability within Ghanaian university settings.

LITERATURE REVIEW

Petroleum Spillage and Environmental Impacts

Petroleum spillages are widely recognized as a major source of environmental degradation due to the introduction of hydrocarbons and volatile organic compounds (VOCs) into ecological systems. These substances alter soil chemistry, reduce soil fertility, and disrupt microbial processes essential for nutrient cycling (Michel et al., 2013). Hydrocarbon infiltration into groundwater further threatens potable water sources and aquatic habitats, often leading to long-term ecological imbalances. In the atmosphere, VOCs volatilized from petroleum residues contribute significantly to air pollution, including the formation of ground-level ozone and smog, which adversely affect human respiratory health. These findings highlight the multidimensional nature of petroleum contamination, encompassing soil, water, and atmospheric domains.

Lubricant Spillage and Long-Term Ecological Risks

Lubricant spillage particularly used engine oils pose an even more persistent environmental threat compared to petroleum products. Used lubricants contain hazardous substances such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals including zinc, lead, and chromium, which do not readily degrade and therefore accumulate in soil and water bodies over time (Thakur & Koul, 2022). These contaminants impair vegetation growth by altering soil structure and limiting nutrient uptake. Moreover, the bio accumulative nature of heavy metals enables their transfer into food chains, posing risks to both wildlife and human populations (Selamoglu, 2021). Unlike lighter petroleum fractions that may evaporate or undergo partial biodegradation, lubricant residues are highly stable, leading to prolonged ecological exposure and increased remediation costs.

Collectively, the empirical evidence underscores that lubricant spillage presents long-term, persistent environmental hazards that require robust institutional spill-management systems.

Social and Occupational Dimensions of Petroleum and Lubricant Spillages

Beyond ecological impacts, petroleum and lubricant spillages have significant social and occupational implications. Workers who handle petroleum products are frequently exposed to chemical residues and fumes that increase the risk of respiratory illnesses, skin irritation, headaches, and long-term health complications (Selamoglu, 2021). Poorly managed spill areas also increase the likelihood of fire outbreaks, posing additional safety risks, particularly in transport and mechanical service environments.

At the institutional level, inadequate environmental safety practices may lead to reputational damage, reduced stakeholder trust, and conflict with the sustainability commitments typically adopted by higher education institutions (HEIs). Huynh et al. (2021) emphasize that ineffective spill-handling procedures may undermine an institution's public image, particularly when pollution impacts surrounding communities or campus environments.

Thus, the social dimensions of petroleum and lubricant spillage extend beyond personal health, incorporating institutional accountability, public perception, and organizational safety culture.

Conceptual Framework: Socio-Environmental Impact Model

The conceptual framework in Figure1 below illustrates the relationship between routine petroleum and lubricant management activities and their socio-environmental consequences within the University of Cape Coast (UCC) Transport Section. It is grounded in environmental pollution, occupational health, and institutional sustainability principles. Routine activities, including vehicle fueling, servicing, lubricant storage, and waste oil disposal, present potential sources of petroleum and lubricant spillages when appropriate handling and environmental management practices are lacking.

The framework conceptualizes spillages as the central phenomenon through which operational activities generate two interrelated outcomes: **environmental impacts** and **social impacts**. Environmental impacts include soil contamination, groundwater and surface water pollution, air pollution from volatile organic compounds (VOCs), vegetation degradation, and biodiversity loss. Social impacts comprise occupational health risks, fire and safety hazards, reduced workplace safety, institutional reputational damage, and environmental regulatory non-compliance.

The framework further posits that these environmental and social consequences collectively influence **institutional sustainability**. Effective spill prevention and management enhance environmental stewardship, occupational health and safety, regulatory compliance, and sustainable transport operations, whereas poor spill management increases environmental degradation and operational risks. Consequently, the framework guided the study by providing a logical basis for examining the occurrence of petroleum and lubricant spillages, assessing their socio-environmental impacts, and identifying practical strategies for improving environmental management within the UCC Transport Section.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

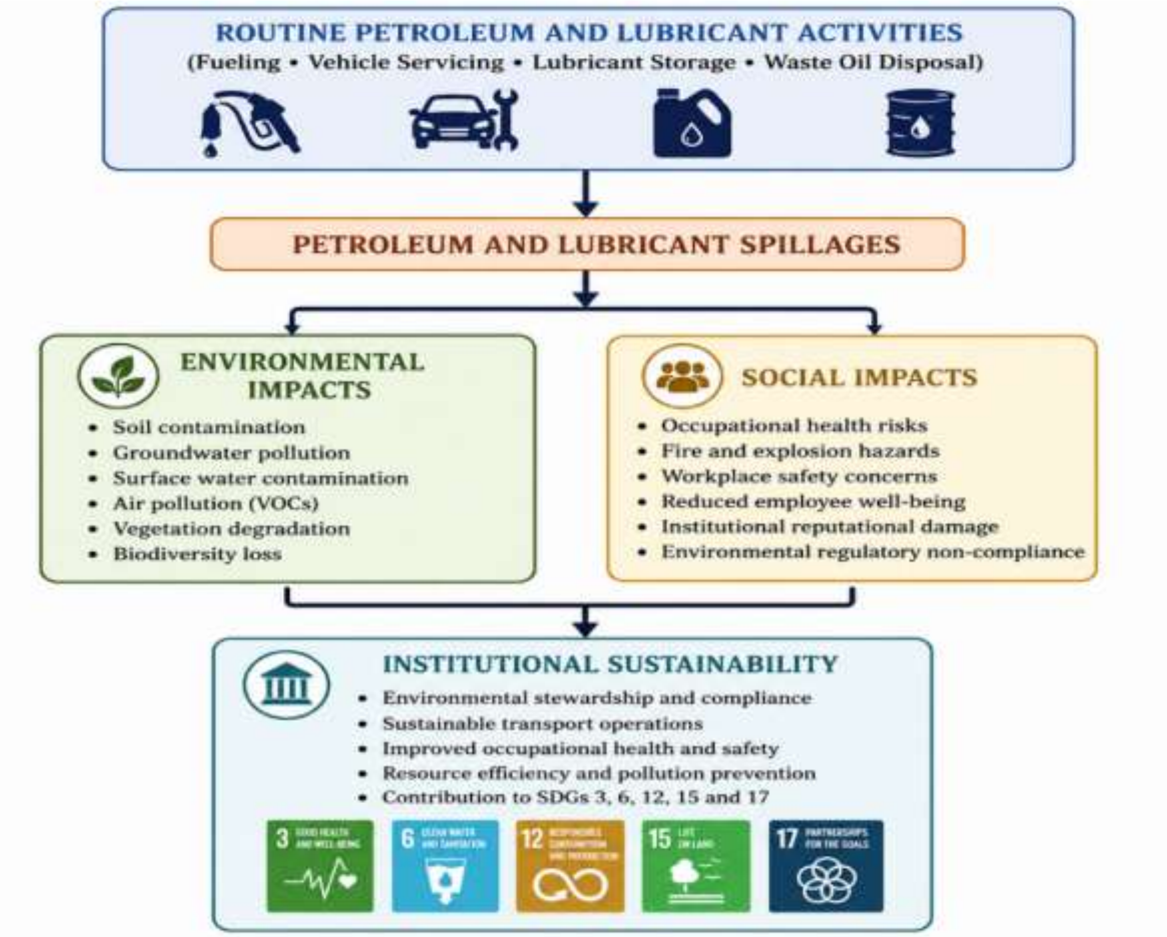

FIGURE 1 Conceptual framework of the socio-environmental impacts of petroleum and lubricant spillages at the University of Cape Coast Transport Section

METHODS

Research Design

This study adopted a mixed-methods case study design (Yin, 2018) to investigate the socio-environmental impacts of petroleum and lubricant spillages at the Transport Section of the University of Cape Coast (UCC). The case study approach was appropriate because it enabled an in-depth examination of operational practices, staff experiences, and environmental conditions within a naturally occurring institutional setting. By focusing on a single bounded system and the transport operations of a public university, the design allowed for rich contextual analysis of spill dynamics, management practices, and institutional vulnerabilities.

Although qualitative inquiry formed the core of the study, incorporating interviews, field observations, and document reviews, the research also integrated basic quantitative elements such as descriptive statistics and selected structured questionnaire items. This mixed-methods orientation enhanced methodological rigor by providing a more comprehensive understanding of the spill-related impacts. Qualitative insights illuminated staff perceptions, behavioural patterns, and institutional practices, while quantitative data enabled systematic reporting and triangulation of observed environmental and occupational outcomes.

Overall, the mixed-methods case study design offered the depth, flexibility, and analytic breadth necessary to explore the complex interactions between operational processes, environmental risk, and organisational behaviour within the UCC Transport Section.

Study Site

The study was conducted at the Transport Section of the University of Cape Coast (UCC), located at 5°06'27.0"N 1°16'53.6"W (5.107510, -1.281550), within the Cape Coast Metropolis in Ghana. The Section manages a substantial institutional fleet estimated at approximately 250–350 vehicles, including saloons, buses, pickups, ambulances, and various utility vehicles that support academic, administrative, and operational activities across the university. Core functions of the unit such as vehicle routine servicing, mechanical repairs, fueling, and the handling and disposal of used lubricants involve frequent contact with petroleum products and thus present recurring risks of spillages.

The physical layout of the Transport Section further heightens environmental sensitivity. The site is bordered by open drains, unpaved service areas, and patches of vegetation, all of which serve as potential pathways for hydrocarbon contamination when spillages occur. These conditions make the area particularly vulnerable to soil degradation, drainage pollution, and vegetation loss. Given the scale of activities and the environmental exposure of the site, the UCC Transport Section represents a critical setting for assessing the socio-environmental implications of petroleum and lubricant spillages within a higher education institutional context.

FIGURE 2. Satellite image showing the Transport Section of University of Cape Coast

Participants and Sampling

A total of 122 staff members were selected from a population of 175 staff in the Transport Section using Yamane's (1967) formula at a 5% margin of error. Of the 122 selected staff, 100 completed and returned the structured questionnaires, while 22 staff participated in semi-structured interviews, resulting in 122 participants contributing data to the study. The questionnaire response rate was 81.97%. To ensure adequate representation of the unit's functional structure, proportionate stratified sampling was used to group questionnaire participants into drivers, mechanics, and administrative personnel, followed by simple random sampling within the respective strata. Interview participants were purposively selected based on their direct experience with vehicle servicing, fuelling, lubricant handling, waste management, and spill-related activities. This approach ensured that both quantitative and qualitative data were obtained from personnel with relevant operational knowledge of petroleum and lubricant management within the Transport Section.

Data Collection Procedures

Data were collected using two complementary primary data-collection instruments: a structured questionnaire and a semi-structured interview guide. The structured questionnaire was administered to 100 staff selected from the Transport Section and was designed to obtain quantitative information on the occurrence, perceived environmental effects, occupational health and safety implications, and institutional consequences of petroleum and lubricant spillages. In addition, semi-structured interviews were conducted with 22 purposively selected staff who had direct experience with vehicle servicing, fuelling, lubricant handling, waste disposal, or spill-management activities. The interviews provided detailed accounts of participants' experiences and perceptions regarding the causes, consequences, and management of petroleum and lubricant spillages. Field observations were also undertaken to document visible evidence of spillages, waste-handling practices, drainage conditions, vegetation impacts, and existing containment measures. Relevant institutional documents were reviewed to provide contextual information on transport operations and environmental management practices. Participation was voluntary, and participants were informed of the purpose of the study before data collection.

Data Analysis

Quantitative data obtained from the 100 completed questionnaires were coded and analysed using descriptive and inferential statistical techniques. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise respondents' characteristics and their assessments of petroleum and lubricant spillages and associated socio-environmental impacts. Pearson's product-moment correlation coefficient was used to examine the direction and strength of relationships among the measured socio-environmental variables. Statistical results were interpreted based on the observed values in the dataset. Qualitative data obtained from the 22 semi-structured interviews, field observations, and relevant institutional documents were analysed thematically. The analysis involved familiarisation with the data, identification and coding of recurring concepts, grouping of related codes into themes, and interpretation of the themes in relation to the study objectives and conceptual framework. The integration of quantitative and qualitative findings provided a broader understanding of the environmental, occupational, social, and institutional implications of petroleum and lubricant spillages within the Transport Section.

RESULTS

Extent and Patterns of Spillage

Spillage of petroleum and lubricants was reported as **frequent and recurrent**, particularly during oil changes, fueling activities, and handling of used oils. Observational findings confirmed:

- Oil stains and hydrocarbon residues on servicing floors
- Pooling diesel near drains
- Contaminated soil patches in open work yards

These conditions indicate inadequate containment and improper waste-handling practices.

TABLE 1 Extent of Reported Petroleum and Lubricant Spillages

Spillage Context	Frequency (%)
Oil changes during servicing	86%
Fuel dispensing activities	73%
Handling of used oil containers	68%
Waste-oil transfer/storage	62%
Accidental leakages from faulty vehicles	41%

Note. Values reflect staff reports from 100 questionnaires.

Environmental Impacts

Soil Contamination

Staff and observations confirmed widespread visible indicators consistent with soil contamination, characterized by:

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

- Darkened hydrocarbon-laden soil
- Hardened, compacted texture
- Barren patches unable to support vegetation

Similar effects are documented in hydrocarbon-polluted soils worldwide (Okoro et al., 2020).

Vegetation Degradation

Areas surrounding workshops and drainage channels showed withered grass and dead vegetation. Hydrocarbon toxicity typically inhibits plant enzymatic activity and growth (Adeniyi et al., 2019).

Water Pathway Risks

Open drainage systems at the site raised concerns regarding:

- Downstream movement of contaminants
- Potential infiltration of hydrocarbons into groundwater

This aligns with global studies demonstrating the mobility of petroleum contaminants in unlined drains (Abdulraheem et al., 2021).

Observed Zones of Soil and Vegetation Contamination Within the Transport Section

Description:A site map illustrating heavily contaminated areas: vehicle servicing bay, oil disposal corner, fueling zone, and drainage channels. Contamination intensity indicated by shading (darkest = most severe).

Social and Health Impacts

Health Effects on Staff

Participants reported consistent symptoms, including: headaches, respiratory irritation, nausea and skin irritation, which they associated with exposure to petroleum products and lubricants and these findings align with occupational exposure literature on petroleum workers (Nawafleh et al., 2022).

Safety Hazards

Pooling oil residues created **fire risks**, particularly in enclosed workshops. Staff also expressed fear of slips, falls, and tool contamination.

Institutional and Reputational Impacts

Respondents believed poor waste management practices:

- Contradict UCC's environmental sustainability goals
- Potentially undermine public trust
- Suggest noncompliance with environmental standards

Such reputational risks have been documented in similar institutional studies (Mensah & Adams, 2021).

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

TABLE 2 Summary of Ecological and Social Impacts Identified

Impact Category	Evidence Observed / Reported
Soil contamination	Darkened soil, barren patches, oil infiltration
Vegetation loss	Withered grass near workshop and drains
Water contamination risk	Oil pooling near open drains
Health impact	headaches, skin irritation, respiratory discomfort
Safety hazard	Fire risks from pooling oil
Institutional image	Perceived contradiction with sustainability goals

Table 3 Descriptive Statistics for Key Socio-Environmental Variables

Variable	Mean	SD	Minimum	Maximum
Spillage Frequency Index	3.87	0.71	2.10	5.00
Soil Contamination Score	4.12	0.66	2.40	5.00
Vegetation Degradation Score	3.95	0.74	1.80	5.00
Water Risk Score	3.68	0.82	1.50	5.00
Health Impact Scale	3.74	0.79	1.60	5.00
Safety Risk Scale	4.05	0.70	2.50	5.00
Institutional Reputation Impact	3.89	0.76	1.80	5.00

N.B.: Descriptive statistics are based on responses from 100 questionnaire participants.

Correlation Analysis (Pearson R)

Table 4 Correlation Matrix for Key Socio-Environmental Variables

Variable	Soil Contamination	Vegetation Loss	Water Risk	Health Impact	Safety Hazard	Reputation
Spillage Frequency	**.62***	**.58***	**.55***	**.49***	**.53***	**.41***
Soil Contamination	—	.71***	.64***	.57***	.61***	.46***
Vegetation Loss	—	—	.59***	.52***	.47***	.43***

**p < .001

Interpretation: Spillage frequency showed **positively correlated** associations with assessed ecological and social impacts indicators.

Table 4 presents the Pearson correlation coefficients among the key socio-environmental variables examined in the study. The results indicate positive associations among the variables, suggesting that higher reported frequencies of petroleum and lubricant spillages were generally associated with greater perceived environmental and social impacts. In particular, the positive relationship between spillage frequency and soil contamination indicates that more frequent spill incidents were associated with higher reported levels of soil-related impacts. Similarly, the observed relationships between spillage frequency and vegetation degradation, water-related risks, occupational health concerns, safety risks, and institutional reputation suggest that spillages may have consequences extending beyond the immediate point of occurrence. These findings however, is interpreted as **associations rather than evidence of causality**. Because the study relied on questionnaire responses, field observations, and qualitative accounts rather than laboratory analysis of environmental samples, the reported environmental relationships represent perceived and observed impacts rather than chemically verified contamination.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

DISCUSSION

The findings demonstrate that petroleum and lubricant spillages constitute a significant socio-environmental management concern within the UCC Transport Section. The spillages were mainly associated with routine transport activities, including vehicle servicing, fuelling, lubricant handling, and waste disposal. This finding is consistent with previous research indicating that petroleum-related activities can generate environmental risks when handling, storage, maintenance, and waste-management practices are inadequate (Fingas, 2013; Thakur & Koul, 2022). Although the present study did not undertake laboratory analysis of soil or water samples, field observations and participant accounts indicated visible evidence of spillages and perceived environmental consequences, including soil degradation, vegetation deterioration, and potential risks to water resources.

The findings further indicate that the environmental implications of spillages extend beyond the immediate areas in which petroleum products and lubricants are released. Participants reported concerns regarding soil contamination, vegetation degradation, and possible contamination of drainage and water systems. These observations are consistent with the established literature on the persistence and mobility of petroleum hydrocarbons in environmental media (Fingas, 2013). The study therefore reinforces the importance of preventing repeated and uncontrolled releases within institutional transport facilities. However, because environmental samples were not collected and chemically analysed, the findings should be understood as observed and perceived environmental impacts rather than laboratory-confirmed contamination.

The study also identified important occupational health and safety implications. Participants reported concerns relating to respiratory irritation, skin irritation, headaches, nausea, fire hazards, and general workplace safety. These findings are consistent with literature linking occupational exposure to petroleum products and related chemicals with adverse health and safety risks (Huynh et al., 2021). The combination of petroleum products, lubricants, inadequate spill containment, and workshop activities may increase the vulnerability of workers, particularly those directly involved in vehicle maintenance, fueling, and waste handling. These findings underscore the need to integrate spill prevention with broader occupational health and safety management within university transport operations.

The positive relationships observed among spillage frequency and the reported environmental and social impact variables further suggest that spill-management practices should not be considered solely as environmental protection measures. Rather, they form part of a broader institutional risk-management system. The observed associations between spill frequency, environmental impacts, occupational concerns, safety risks, and institutional reputation indicate that repeated spill incidents may have implications for employee welfare, workplace safety, environmental compliance, and stakeholder perceptions. Nevertheless, these relationships should be interpreted as associations and not causal effects because the study design does not establish causality.

A further important finding concerns the role of institutional infrastructure and management practices. Participants identified inadequate containment facilities, weaknesses in waste-management practices, and limited awareness of spill-prevention procedures as factors contributing to spill-related risks. This observation supports the broader environmental-management literature, which emphasizes the importance of preventive infrastructure, employee awareness, monitoring, and compliance mechanisms in reducing pollution risks. Within university environments, such measures are particularly relevant because transport operations are embedded within institutions that have responsibilities for environmental stewardship, occupational safety, and sustainable resource management.

The findings also have implications for institutional sustainability. Effective management of petroleum and lubricant spillages can contribute to improved environmental stewardship, occupational health and safety, regulatory compliance, resource efficiency, and institutional reputation. Conversely, persistent spillages and inadequate waste-management practices may increase environmental and operational risks. The findings therefore support the integration of transport-related environmental management into broader institutional sustainability policies and practices. This is particularly relevant to higher education institutions, which are expected not only to provide educational services but also to demonstrate responsible environmental and social practices.

Overall, the findings support the conceptual framework of the study, which proposes a pathway from routine petroleum and lubricant activities through spillages to environmental and social impacts and, ultimately, institutional sustainability. The study therefore contributes to the limited empirical literature on petroleum and lubricant management within higher education transport systems in Ghana. It demonstrates that institutional transport facilities, although relatively localised sources of petroleum-related pollution, require systematic environmental management because repeated small-scale spillages may accumulate into broader occupational, environmental, and institutional risks. Aligning transport operations with SDG frameworks presents an opportunity for UCC to strengthen sustainability governance, particularly SDG 3 (Health), SDG 6 (Water), SDG 12 (Responsible Consumption), and SDG 15 (Life on Land). Institutional commitment to environmental protection is crucial in mitigating long-term risks. The findings should therefore be interpreted within the methodological scope of the study, particularly the reliance on participant reports and field observations rather than laboratory-based environmental measurements.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Petroleum and lubricant spillages at the UCC Transport Section produce significant socio-environmental consequences, including soil degradation, vegetation loss, water contamination risks, occupational health hazards, and reputational concerns. Weak infrastructure, limited awareness, and inconsistent enforcement of safety protocols exacerbate these impacts. A systemic institutional response is therefore essential.

Recommendations

1. **Install environmental protection infrastructure** by providing oil interceptors, impermeable flooring, sealed storage tanks, and designated facilities for the collection, storage, and safe disposal of used oils and lubricant containers. These measures will help prevent uncontrolled discharge and reduce petroleum residues entering soils and drainage systems.
2. **Enhance staff capacity** through regular training on spill prevention, hazardous-material handling, waste-oil management, and emergency response procedures. Clear spill-response protocols should also be established.
3. **Conduct periodic environmental audits** to monitor potential contamination, evaluate compliance with environmental and occupational safety requirements, identify weaknesses in spill-management practices, and strengthen institutional accountability.
4. **Integrate environmental sustainability into transport operations** by establishing clear policies on petroleum-product handling, waste-oil management, spill reporting, emergency response, and environmental compliance, consistent with relevant national requirements and SDG commitments.
5. **Adopt environmentally preferable technologies and lubricants**, including biodegradable or less-polluting alternatives where technically, economically, and operationally feasible, to reduce the long-term ecological footprint of transport operations.

Limitations and Future Research

A limitation of this study is that environmental impacts were assessed through field observations and stakeholder perceptions rather than laboratory analysis of soil or water samples. Consequently, the findings reflect observed conditions and respondents' experiences rather than quantitative measures of environmental contamination. Future studies could quantify contaminant levels in soil and water, incorporate physicochemical and laboratory analyses to provide a more comprehensive assessment of petroleum and lubricant contamination and also compare spill-management practices across multiple higher education institutions in Ghana.

ACKNOWLEDGEMENT

Ethical Declaration: In accordance with established research protocols, the necessary permissions and ethical approvals were obtained from the relevant authorities before the study commenced. These approvals authorised the researcher to undertake the study and engage with the selected participants. Throughout the research process, ethical principles, including confidentiality, participants' autonomy, privacy, and anonymity, were strictly observed. Participation was voluntary, with informed written consent obtained from each participant.

Author Contributions: Concept: William K. Yaro, George N. Appertey, Kwakye A. Owusu. Design: William K. Yaro, George N. Appertey, Kwakye A. Owusu. Supervising: George N. Appertey, William K. Yaro. Data collection and entry: William K. Yaro, George N. Appertey, Kwakye A. Owusu. Literature search: George N. Appertey, William K. Yaro. Writing: William K. Yaro, George N. Appertey, Kwakye A. Owusu.

Financial Disclosure: The authors declared that no financial support was received for this study.

Conflict of Interest: The authors declare that there is no conflict of interest.

Declaration on the Use of Artificial Intelligence: The author declares that an artificial intelligence (AI) tool was **not used** to generate, fabricate, manipulate, or analyse the research data, findings, or statistical results. The AI tool was **used solely** as an auxiliary tool during the preparation of this manuscript, particularly for grammatical refinement, language editing, and assistance with the identification and formatting of relevant references. All references, citations, interpretations, and substantive content were reviewed and verified by the authors, who retains full responsibility for the accuracy, originality, integrity, and final content of the manuscript.

REFERENCES

1. Abdulraheem, M., Hassan, R., & Bello, A. (2021). Hydrocarbon contamination pathways in open drainage systems. Environmental Monitoring and Assessment, 193(4), 1–15.
2. Abereton, P., Ordinioha, B., Mensah-Attipoe, J., & Toyinbo, O. (2023). Crude oil spills and respiratory health of clean-up workers: A systematic review of literature. Atmosphere, 14(3), 494.
3. Adeniyi, O., Ojo, D., & Fashola, M. (2019). Effects of petroleum hydrocarbons on soil chemical properties and plant growth. Environmental Pollution Studies, 44(2), 155–168.
4. Adofo, Y. K., Nyankson, E., & Agyei-Tuffour, B. (2022). Dispersants as an oil spill clean-up technique in the marine environment: A review. Heliyon, 8(8), e10266.
5. Altbach, P. G., Reisberg, L., & Rumbley, L. E. (2019). Trends in global higher education: Tracking an academic revolution. UNESCO Publishing.
6. Barker, C. H., Kourafalou, V. H., Beegle-Krause, C. J., Boufadel, M., Bourassa, M. A., Buschang, S. G., & Zheng, Y. (2020). Progress in operational modeling in support of oil spill response. Journal of Marine Science and Engineering, 8(9), 668.
7. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101.
8. Carls, M. G., Holland, L., Larsen, M., & Collier, T. K. (2004). Exxon Valdez oil spill: Fate and effects in Alaskan waters. ASTM International.
9. Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.
10. Environmental Protection Agency (EPA) Ghana. (2020). Environmental compliance guidelines for transport workshops. EPA Ghana.
11. Etkin, D. S., & Nedwed, T. J. (2021). Effectiveness of mechanical recovery for large offshore oil spills. Marine Pollution Bulletin, 163, 111848.
12. Fetters, M. D., & Freshwater, D. (2015). The mixed methods research process: Advancing rigour in methodology. Journal of Mixed Methods Research, 9(3), 292–299.
13. Fingas, M. F. (2013). The basics of oil spill cleanup (3rd ed.). CRC Press.
14. Hanyabui, E., et al. (2021). Effect of spilled engine oil on soil quality indicators and physiological performance of maize, cowpea and sorghum. African Journal of Environmental Science and Technology, 15(7), 262–269. https://doi.org/10.5897/AJEST2021.2999

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VIII August 2026

15. Huynh, T., Pham, T., & Nguyen, H. (2021). Health risks associated with petroleum exposure: A review of occupational impacts. International Journal of Environmental Health Research, 31(5), 567–580.
16. Kwao-Boateng, E., et al. (2022). Re-refining used engine oil in Ghana using solvent extraction and acid-clay treatment. International Journal of Chemical Engineering, 2022, Article 6344409.
17. Mensah, J., & Adams, F. (2021). Institutional environmental compliance in Ghana's public universities. Journal of Environmental Management, 292, 112–135.
18. Michel, J., Owens, E. H., Zengel, S., Graham, A., Nixon, Z., Allard, T., Holton, W., Reimer, P. D., Lamarche, A., White, M., Rutherford, N., Childs, C., Mauseth, G., Challenger, G., & Taylor, E. (2013). Extent and degree of shoreline oiling: Deepwater Horizon oil spill, Gulf of Mexico, USA. PLoS ONE, 8(6), e65087.
19. Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). Qualitative data analysis: A methods sourcebook (3rd ed.). SAGE Publications.
20. Monteiro, C. B., Oleinik, P. H., Leal, T. F., Marques, W. C., Nicolodi, J. L., & Lopes, B. D. C. F. L. (2020). Integrated environmental vulnerability to oil spills in sensitive areas. Environmental Pollution, 267, 115238.
21. National Academy of Sciences. (2015). Spills of diluted bitumen from pipelines: A comparative study of environmental fate, effects, and response. National Academies Press.
22. National Research Council. (2003). Oil in the sea III: Inputs, fates, and effects. National Academies Press.
23. Nawafleh, H., Ali, S., & Farhan, M. (2022). Occupational exposure to petroleum hydrocarbons and worker health outcomes. International Journal of Environmental Health Research, 32(5), 1034–1047.
24. Nyarko, H. D., Okpokwasili, G. C., Joel, O. F., & Galyuon, I. A. K. (2019). Effect of petroleum fuels and lubricants on soil properties of auto-mechanic workshops and garages in Cape Coast Metropolis, Ghana. Journal of Applied Sciences and Environmental Management, 23(7), 1287–1294
25. Okoro, C., Nnaji, C., & Agha, L. (2020). Soil toxicity effects of spent engine oil contamination. Journal of Environmental Toxicology, 14(1), 45–58.
26. Selamoglu, Z. (2021). Environmental impacts of petroleum-derived pollutants and remediation strategies. Environmental Science and Pollution Research, 28(12), 14567–14578.
27. Sveum, P., Nedwed, T., & King, T. (2009). Ecological consequences of oil spills: A review and framework for informing planning. Ecological Applications, 19(1), 196–209.
28. Thakur, A., & Koul, B. (2022). Impact of oil exploration and spillage on terrestrial and aquatic environments. In A. Thakur & B. Koul (Eds.), Advances in oil–water separation (pp. 115–135). Elsevier.
29. UNEP. (2018). Environmental management in higher education institutions: Sustainability practices and policies. United Nations Environment Programme.
30. UNESCO. (2020). Education for sustainable development: A roadmap. UNESCO Publishing.
31. Yin, R. K. (2018). Case study research and applications: Design and methods (6th ed.). SAGE Publications.