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Community Empowerment through Hotel Waste Management System Improvement by University Students and Lecturers

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Abstract

This community service and applied research project was designed to address critical issues in hotel waste management systems, particularly the functionality and maintenance of grease traps and wastewater drainage infrastructure. Ineffective management of these systems in the hospitality sector can lead to environmental pollution, health hazards, and operational inefficiencies. The project aimed to empower hotel stakeholders through technical assessment, capacity building, and collaborative problem-solving, while simultaneously offering experiential learning opportunities for university students. The methodology involved a series of structured activities, including pre-engagement discussions, formal coordination with hotel management, technical field assessments, on-site demonstrations, and participatory planning sessions. Students, lecturers, and hotel staff collaborated to assess the condition of the waste systems, identify weaknesses, and co-develop site-specific, feasible improvement strategies. Observations and data collection focused on grease trap design, drainage layout, system maintenance routines, and real-time system flow behaviour. Key outcomes included improved awareness among hotel personnel, enhanced technical competencies among students, and the development of practical recommendations for improving system efficiency. One of the novel aspects of this project is its integrated academic-industry collaboration model, where students serve as both learners and contributors in solving real-world environmental challenges. Unlike conventional outreach programs, this initiative emphasised mutual empowerment, hands-on involvement, and sustainable, locally adapted solutions. In conclusion, this project demonstrates a replicable model of community empowerment through university–industry partnership. It reaffirms the role of higher education institutions in promoting sustainable development by bridging academic knowledge with practical environmental solutions for local industries.

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1. Introduction

Waste management in the hospitality sector, particularly hotels, plays a vital role in environmental sustainability and public health. The growing awareness of environmental impacts has prompted many

researchers to focus on improving waste management practices in commercial establishments. Inefficient disposal of wastewater and food-related waste can lead to contamination, odour, and health risks, especially when grease traps and drainage systems are poorly maintained [1]. Grease traps are widely used in hotels and restaurants to separate fats, oils, and grease (FOG) from wastewater before it enters the public sewer system. However, their effectiveness depends heavily on routine maintenance and system design [2]. Studies show that improperly managed grease traps contribute significantly to sewer blockages and pollution [3]. Hence, continuous monitoring and technical evaluation of such systems are essential.

Several previous works have emphasised the importance of integrating environmental engineering knowledge into waste management planning in commercial settings. For example, site-specific assessments, stakeholder engagement, and participatory interventions have proven effective in improving waste system performance [4], [5]. Moreover, engaging academic institutions in real-world problem-solving enhances both community capacity and student competencies [6]. Community service programs conducted by universities have shown promising outcomes in addressing local environmental issues through multidisciplinary approaches. These programs not only empower local stakeholders but also provide valuable experiential learning opportunities for students [7]. The application of theoretical knowledge to practical settings allows for deeper understanding and innovation in waste infrastructure design [8].

In the context of hotels, previous research has highlighted that most waste system challenges stem from design constraints, ageing infrastructure, and a lack of technical training among staff [9]. Participatory approaches that involve both field assessment and collaborative planning have been suggested to overcome these limitations [10]. However, empirical studies focused on direct university hotel collaboration in this area remain limited. A recent study emphasised the effectiveness of hands-on training and on-site inspections in improving awareness and performance among hospitality workers, particularly in Southeast Asia [11]. Field demonstrations and guided evaluations helped participants recognise critical points of failure and adapt sustainable practices more effectively than through passive instruction alone [12].

This community engagement project builds upon these findings by integrating a full-cycle participatory model from preliminary stakeholder meetings and technical briefings to field inspection and co-design of system improvements. The collaborative involvement of students, lecturers, and hotel staff ensures not only technical intervention but also behavioural and institutional transformation. This paper presents the results and reflections of a community service and research initiative that focused on improving a hotel's waste management system through technical fieldwork and empowerment-based collaboration. The novelty of this initiative lies in its student-centred methodology, site-specific diagnostics, and emphasis on mutual capacity-building between the academic and hospitality sectors.

2. Methodology

This community service and applied research project adopted a participatory, field-based approach combining qualitative observation, technical assessment, and collaborative engagement. The methodology was structured into five key phases, involving both academic participants (students and lecturers) and the industry partner (hotel management and staff).

Preliminary Coordination and Internal Briefing

Before field deployment, an internal coordination meeting was conducted between lecturers and student participants (**Figure 1**). This session aimed to align objectives, clarify roles, and equip students with knowledge of site-specific issues related to hotel waste management systems. Guidelines for ethical fieldwork, data collection, and communication with stakeholders were also discussed.

Formal Engagement with the Community Service Partner
A formal introductory meeting was held with the hotel management to establish mutual understanding and define the scope of collaboration (**Figure 2**). The meeting addressed operational challenges, stakeholder expectations, and logistical arrangements for field activities.

On-site Technical Briefing and Field Observation
The partner representative conducted an on-site walkthrough and explained the system (**Figures 3–4**), covering grease traps, wastewater discharge paths, and ventilation systems. Students collected data through field notes, photos, and direct questioning. Particular attention was given to system bottlenecks, maintenance routines, and flow dynamics.

Field Assessment and Participatory Mapping
A detailed inspection of the external drainage systems and waste pathways was conducted (**Figures 5–7**). Students measured gradients, assessed component conditions, and collaboratively mapped the layout with input from hotel staff. This phase emphasised co-learning and stakeholder inclusion in the technical evaluation process.

Practical Demonstration and Capacity Building
The final phase involved a live demonstration of flow behaviour in the drainage system (Figure 8), facilitated by the hotel staff. This allowed students to understand real-time system responses and empowered hotel staff with technical insights to support improved operations.

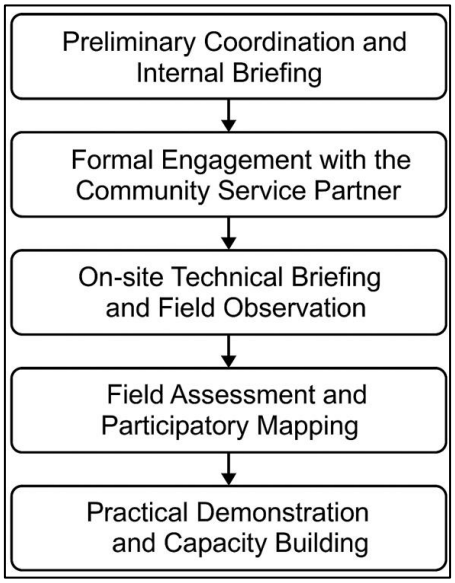

Figure 1: Research and Community Engagement Methodology Flowchart

Figure 1 illustrates the systematic methodology employed in this community service and research initiative, which aims to improve hotel waste management systems. The process begins with Preliminary Coordination and Internal Briefing, ensuring that students and lecturers are aligned in terms of project objectives, technical knowledge, and ethical considerations. This is followed by Formal Engagement with the Community Service Partner, where the university team formally meets with hotel representatives to understand operational challenges and establish mutual expectations. The following stages involve field-based activities, including an On-site Technical Briefing and Field Observation, which provide real-time exposure to waste infrastructure, allowing students to interact directly with practitioners. Subsequently, Field Assessment and Participatory Mapping facilitate collaborative identification of system inefficiencies and spatial layout. The final step, Practical Demonstration and Capacity Building, ensures that both hotel staff and students gain applicable skills through hands-on interaction with drainage and grease trap systems. This structured approach promotes experiential learning, sustainable solutions, and strengthens university–industry partnerships.

All activities were documented and analysed qualitatively. Recommendations were formulated based on system conditions, feasibility, and sustainability. The project methodology emphasised experiential learning, mutual knowledge exchange, and locally adapted technical solutions, representing a comprehensive model of community empowerment through university–industry collaboration.

3. Result & Discussion

The implementation of this community service and applied research project aimed to address real-world environmental challenges in the hospitality sector, particularly those related to the efficiency of waste management systems. Through the collaboration between lecturers, students, and hotel industry partners, the project provided a platform for mutual learning and technical improvement. A series of structured activities was conducted, ranging from initial coordination meetings to detailed field surveys and technical assessments, to ensure that proposed solutions were grounded in practical realities. The involvement of university students in every phase of the project created a dynamic learning environment where academic theories were applied directly to site-specific problems. Simultaneously, hotel staff were actively engaged in identifying inefficiencies and exploring sustainable alternatives for their existing drainage and grease trap systems. The following sections discuss key findings and insights from the field activities, highlighting both the technical and social outcomes of this collaborative initiative in empowering local stakeholders and enhancing environmental performance.

Figure 2: Discussion between Lecturers and Students while Waiting for the Community Service Partner Representative

Figure 2 illustrates the initial stage of coordination and communication among university students, lecturers, and the internal team, before engaging with the community service partner. This meeting was held in a relaxed and comfortable setting, allowing both students and academic staff to align their understanding regarding the objectives and scope of the waste management project to be implemented in a hotel environment. It was crucial to ensure that all team members had a clear grasp of their roles and responsibilities before entering the operational phase. During the discussion, the lecturers provided guidance on how to approach real-world industrial problems, particularly related to waste management practices in the hospitality sector. The students were encouraged to apply their academic knowledge to analyse existing systems, identify inefficiencies, and propose sustainable solutions. This moment also served to build confidence and teamwork among the students, who were about to engage with professionals in a formal setting.

This pre-engagement meeting also emphasised the importance of effective communication strategies and ethical conduct when interacting with industry partners. The team discussed the most effective ways to gather data, pose technical questions, and document field observations during the collaboration. By preparing thoroughly, the academic team aimed to maximise the effectiveness of their community service activities and ensure that the outcomes would be meaningful for both the students' learning and the hotel's operational sustainability. In essence, **Figure 2** illustrates the collaborative spirit and

preparatory effort that underpin the success of community empowerment programs. By fostering early-stage alignment and mutual understanding, university-led initiatives like this are more likely to produce practical solutions for local industries, such as hotels, while simultaneously enhancing students' competence in applying science and technology to real-world societal challenges.

Figure 3: Official Meeting between the Community Service Partner and Academic Delegation for Project Introduction

Figure 3 illustrates the formal meeting held between the university delegation and the hotel management team as the community service partner. This session served as the official introduction to the project, which aims to improve the hotel's waste management system through academic collaboration. The meeting was crucial in aligning the vision and goals of both parties, ensuring a mutual understanding and commitment to the planned interventions. During the session, the hotel representatives provided an overview of their current waste handling practices, the challenges they faced, and their expectations from the university team. This valuable insight allowed lecturers and students to understand the operational context, identify key problem areas, and begin formulating technically sound and applicable solutions. The discussion also helped set realistic timelines and scope for the activities, considering the operational constraints of the hotel.

Lecturers played a key role in bridging academic theory with real-world practice, translating student proposals into practical, actionable steps. This formal setting also trained students in professional communication, documentation, and stakeholder engagement, essential soft skills for community-based projects. The hotel's willingness to engage in this collaborative model demonstrated a shared commitment to sustainability and capacity building. Overall, this official meeting marked a strategic starting point in the community empowerment process. It strengthened institutional relationships, validated the relevance of the student-led initiative, and laid the groundwork for a sustainable waste management improvement plan tailored to the needs of the hospitality industry.

Figure 4 shows an on-site technical briefing conducted by the community service partner representative to the student team. This session was held at a strategic location within the hotel premises where the waste treatment infrastructure is located. The briefing served as a critical moment for the students to understand the real operational flow, system configuration, and practical limitations faced in waste handling processes. The hotel staff provided detailed explanations, supported by technical documents and schematics, which allowed students to connect their theoretical knowledge with the actual system in place. Topics discussed included the functions of grease traps, wastewater flow paths, cleaning

schedules, and the physical challenges associated with maintenance. This practical exposure was essential for identifying priority areas for system enhancement and sustainability planning.

Figure 4: On-site Technical Briefing by the Community Service Partner to the Student Team

The interaction also encouraged students to actively ask questions and clarify their observations, fostering a two-way knowledge exchange. Lecturers acted as facilitators, ensuring that discussions remained focused and educational. Through this briefing, students were empowered to collect primary data for designing innovative, yet feasible improvement strategies aligned with hotel operations. This moment marked the transition from planning to field engagement, highlighting the value of collaborative learning. By involving operational personnel as co-educators, the project not only benefited from practical insights but also promoted the empowerment of both students and the hotel partner as active participants in the transformation of sustainable waste management.

Figure 5 captures the moment of field orientation led by the community service partner, focusing on the technical installation related to waste handling infrastructure. This location housed the hotel's control panel and ventilation system, which are integral to the operation of the grease trap and wastewater disposal. The orientation was designed to give students a first-hand look at the key components that influence system efficiency and maintenance. The representative explained the function of each installed component, including the control system, ventilation ducts, and their relationship to waste flow within the facility. Students gained valuable insights into how real-time monitoring and automation could affect the overall waste treatment process. This form of experiential learning deepened their understanding of system dynamics, far beyond what could be learned from textbooks or classroom simulations.

Additionally, the orientation helped students recognise existing challenges, such as ageing equipment, confined space limitations, and inaccessible maintenance. This understanding was crucial for developing practical improvement plans that consider cost, feasibility, and environmental impact. The lecturers guided students in making technical notes and asking critical questions that would support their final design proposals. Ultimately, **Figure 5** highlights the transition from conceptual planning to technical immersion. By observing the hotel's installed system and learning directly from field experts, students were better equipped to contribute meaningful improvements. This approach not only

empowered students with technical competence but also supported the hotel's efforts in creating a more sustainable and efficient waste management strategy.

Figure 5: Field Orientation on System Installation by the Community Service Partner

Figure 6 illustrates a field survey and location assessment conducted by the hotel's partner representative in collaboration with the university's student team. The activity took place in the outdoor utility area of the hotel, where several infrastructure components related to waste discharge, drainage, and ventilation were located. This direct assessment aimed to map the spatial layout and evaluate the conditions affecting waste flow and system performance. The site walk-through allowed students to observe external waste management elements that are often overlooked in documentation, such as piping layout, slope, access points, and environmental exposure. This practical insight was essential to develop a more comprehensive waste management improvement proposal that accounts for both internal processes and external flow routes. Additionally, the group discussed potential health and safety concerns tied to current installations.

Figure 6: Field Survey and Location Assessment Conducted by Partner Representative and Student Team

Through this assessment, students practised site documentation techniques, including sketching layouts, recording environmental conditions, and conducting interviews with field personnel. Such real-world exposure enhanced their analytical capabilities and introduced them to industry-level assessment practices. The partner representative played an important mentoring role, offering practical insights into operational challenges and technical considerations. Overall, **Figure 6** reflects a strong spirit of collaboration and knowledge exchange. The field survey served not only as a data collection phase but also as a form of participatory learning, where both the academic team and hotel staff actively engaged in identifying problems and co-developing solutions. This hands-on approach is crucial to empowering communities through sustainable and contextually aware interventions.

Figure 7: Inspection of the Grease Trap System by the Partner Representative during Field Assessment

Figure 7 documents a critical moment in the field assessment: the direct inspection of the hotel's grease trap system by the community service partner representative. The grease trap plays a vital role in separating oil, fat, and food waste from wastewater before it enters the sewer system. Its condition provides clear indicators of maintenance effectiveness and operational hygiene. During the inspection, the representative demonstrated how the grease trap functions and explained common problems, including clogging, unpleasant odours, and overflow, which can occur due to irregular cleaning schedules. This was a valuable learning opportunity for the student team, who were able to visually assess waste accumulation and evaluate the physical condition of the infrastructure.

The students were encouraged to take notes, capture photographs, and ask technical questions regarding the frequency of cleaning, design capacity, and possible modifications to improve flow and efficiency. This hands-on experience helped them understand how design flaws or a lack of routine maintenance can directly impact the environmental footprint of a hospitality facility. Overall, **Figure 7** reflects the project's practical and solution-oriented approach. By involving students in the inspection of real operational systems, the project promoted awareness of industrial waste challenges while equipping future engineers and environmental practitioners with the tools to address them through collaborative, evidence-based strategies.

Figure 8: Technical Survey and Planning Session Conducted by Students and Partner Representative at the Site

Figure 8 captures the technical survey and planning session conducted directly at the hotel site by the student team in collaboration with the community service partner. This session was crucial in validating preliminary data and aligning the field conditions with the proposed waste management improvement strategies. It marked a pivotal phase where theoretical designs were matched with spatial and infrastructural realities. During the session, students measured surface gradients, noted existing drainage paths, and identified potential modifications to optimise waste flow and prevent waterlogging or backflow. The site also presented challenges, such as limited access points, exposed piping, and ageing infrastructure, all of which needed to be addressed in the redesign. Input from the hotel's technical staff added depth to the students' planning by providing historical context and operational limitations.

The team engaged in focused discussions, using sketches and field notes to map out possible interventions, such as repositioning grease trap access, enhancing ventilation, or introducing filtration solutions. This collaborative approach ensured that the final proposals would be not only environmentally sound but also practically feasible for hotel staff to operate and maintain. **Figure 8** illustrates the dynamic interaction between academic knowledge and field practicality. It showcases how student involvement in real-world planning fosters critical thinking, teamwork, and stakeholder engagement essential competencies for community-based problem-solving. The session strengthened both technical planning and mutual understanding between the academic team and the hotel, making it an empowered partner in sustainable waste management.

Figure 9 captures a hands-on explanation session where the community service partner representative demonstrated the actual drainage mechanism used at the hotel. This session aimed to explain to students how wastewater travels from the kitchen and service areas through the piping network, ultimately leading to the grease trap and external discharge systems. Observing this process on-site allowed students to visualise flow behaviour and system interaction more clearly than from blueprints alone. The demonstration highlighted practical issues commonly encountered in the field, including grease buildup, sediment blockage, and uneven flow resulting from poor gradient design. Students were able to ask specific technical questions about maintenance procedures, drainage slope optimisation, and potential environmental risks. The hose used in the demonstration simulated flow, enabling participants to better understand drainage dynamics in real-time.

By observing and discussing these elements directly at the site, students developed a more nuanced understanding of how theory and practice intersect in waste system management. They also learned how to propose realistic design improvements, taking into account factors such as existing infrastructure, cost constraints, and user behaviour. The presence of both lecturers and hotel technicians ensured a multidisciplinary perspective was maintained throughout the session. **Figure 9** thus marks the culmination of the fieldwork phase, solidifying student competencies in assessing and redesigning waste infrastructure in real-world settings. The activity reinforced the community empowerment objective of the program, as it fostered mutual knowledge exchange and built the hotel staff's capacity to collaborate on sustainable, university-supported solutions.

Figure 9: Practical Explanation of Drainage Mechanism Provided to Students on Site

The novelty of this community service project lies in its integrated approach to empowering hotel industry stakeholders through direct academic collaboration, specifically targeting improvements in waste management systems. Unlike conventional outreach programs that primarily focus on education or infrastructure donations, this initiative combines technical field assessments, capacity building, and student-led system redesign in a real industrial setting. A unique aspect of the project is the use of a learning-by-doing model, where students not only observe but actively participate in technical evaluations, stakeholder discussions, and problem-solving. This approach creates dual impacts: enhancing student competency in environmental engineering practices while simultaneously equipping hotel staff with practical knowledge to maintain and improve their existing drainage and grease trap systems.

Furthermore, the project introduced site-specific analysis and design proposals that consider local infrastructure limitations, environmental risk factors, and operational feasibility. The involvement of hotel technical staff as co-educators represents a novel form of mutual empowerment, where knowledge is not only transferred but co-developed. This aligns with the current global shift toward participatory and sustainable community development practices. Lastly, the project demonstrates how universities can play a strategic role in supporting local industries through applied research and community service, with scalable potential for replication in other hospitality establishments. The blend of academic rigour, technical implementation, and community partnership offers a novel model for impactful, evidence-based community engagement in environmental management.

4. Conclusion

This community service and applied research project has successfully demonstrated the effectiveness of collaborative engagement between university students, academic staff, and hotel industry partners in improving the local waste management system. Through a series of structured activities, including pre-engagement discussions, formal meetings, technical briefings, field observations, and hands-on demonstrations, participants assessed existing waste infrastructure, identified operational weaknesses, and proposed realistic and sustainable improvement strategies. The field-based learning approach empowered students to apply their theoretical knowledge in real-world settings while enhancing their communication, teamwork, and problem-solving skills. At the same time, the hotel staff gained valuable insights into best practices for grease trap maintenance, drainage system optimisation, and environmentally responsible waste handling. The active involvement of both academic and industry actors fostered mutual understanding and practical innovation. Notably, the project introduced a participatory and context-specific model of community empowerment, where knowledge was co-created rather than unilaterally transferred. This approach not only addressed technical challenges but also contributed to capacity building and long-term behavioural change among local stakeholders. In conclusion, the initiative represents a replicable model for university-driven community service that integrates education, research, and societal impact. It reaffirms the role of higher education institutions as active contributors to sustainable development through problem-based collaboration with industry and the local community.

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