

## RESEARCH ARTICLE

## A preliminary study of scheduled waste management practices in Malaysia

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**Abstract** - As industrialisation continues to grow, effective scheduled waste management is essential for minimising environmental risks and safeguarding public health. Thus, this study explores the practices, challenges, and safety measures associated with managing scheduled waste. Two companies located in Kuantan, Pahang and one academic institution located in Kerteh, Terengganu, participated in this study. The research employed a qualitative exploratory approach by incorporating semi-structured interviews with six experts from an academic institution and two industries, along with a thorough review of relevant documents. Key findings indicate that while industries generally follow standard operating procedures for waste handling and safety measures, challenges remain in areas such as regulatory compliance, staff awareness, and infrastructure capacity. Notable issues include the absence of formal certification training, budgetary constraints, and inadequate space for temporary waste storage. A SWOT analysis was conducted to identify strengths, weaknesses, opportunities, and threats within existing practices. The study also highlights the importance of enhancing awareness, formalising training programs, and upgrading infrastructure to address the increasing volume of scheduled waste, ultimately ensuring a safer workplace and promoting sustainable waste management practices. These insights offer a foundation for improving scheduled waste management in Malaysia.

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### 1. Introduction

Effective waste management is a critical global challenge as careless disposal of any hazardous waste can bring about devastating effects to the environment (Rajagopal et al., 2025), especially in rapidly industrialising regions. Malaysia's East Coast has experienced significant industrial growth over the years; however, it also causes significant increase in hazardous and scheduled wastes, such as chemicals, e-waste, and industrial sludge. Improper management of these wastes poses serious risks to the environment and human health. Waste management issue is often overshadowed in public and policy discussions despite its critical role in addressing global challenges like pollution, climate change, and biodiversity loss (Lama, 2024). As the world works towards better waste management, Malaysia remains lacking in research within these areas. Most recent studies on waste management in Malaysia have focused on plastic waste management (Kamaruddin et al., 2022) and household waste management (Cheng et al., 2022), while overlooking the effects of rapid urbanisation and industrialisation. Additionally, hazardous and scheduled wastes can have long-term consequences for the ecosystem, especially marine (Chundawat et al., 2024). This is particularly true for coastal regions, such as the East Coast of Malaysia, due to their proximity to the sea.

While there are existing regulations that offer a framework for managing waste materials, the extent to which these regulations are implemented and adhered to in industries remains uncertain. Therefore, this study aims to address the challenges by exploring current waste management practices and identifying areas for improvement using SWOT (Strengths, weaknesses, opportunities and threats) analysis. The objective is to examine the industries' current practices in handling, storing, and disposing of industrial hazardous waste as well as to identify weaknesses and propose actionable recommendations. It also highlights the importance of worker safety by assessing the measures currently put in place to prevent exposure to hazardous materials. These findings are critical for preserving local ecosystems, minimising pollution, and promoting sustainable industrial development, thus contributing towards sustainable development and environmental protection in the region (Simeon, 2025). Beyond its regional implications, this study aligns with global sustainability efforts, particularly the United Nations Sustainable Development Goals (SDGs). It closely relates to SDG 3 (Good health and well-being), SDG 12 (Responsible consumption and production), and SDG 13 (Climate action), hence advocating the collective global efforts towards establishing more sustainable solutions in the future.

Furthermore, this study investigates the classification of scheduled waste for each company, the methods and standard operating procedures (SOPs) for waste handling and disposal, and the safety measures put in place to protect workers from hazardous waste exposures. It further evaluates the challenges industries face in adhering to regulations and explores the types of training provided to employees. Additionally, the study analyses the treatment and disposal methods currently employed, as well as the decision-making processes for improving waste management practices. By addressing these areas, this study provides an understanding of the state of waste management in Malaysia's East Coast, offering

preliminary input for future efforts to improve environmental and occupational health while advancing sustainable development in the region.

## 2. Literature Review

Waste management, including hazardous and scheduled wastes, has become increasingly critical in many countries (Banerjee et al., 2023), particularly those that experience rapid industrial growth. Nevertheless, the issue has not been a priority in many international discussions on climate problems and development. Effective mitigation of the problem requires a shift in focus to global and local wastes (Lama, 2024). According to the National Solid Waste Department, Malaysia currently has 165 landfills, with eight sanitary landfills and three inert landfills for materials such as sand and concrete. Local environmental experts have forecasted that failure to reduce waste will result in the unavailability of space for a proper landfill that does not disrupt the community by 2050 (Daim & Radhi, 2023; International Trade Administration, 2022). The United Nations Environment Programme also predicts that municipal solid waste generation will increase from 2.1 billion tonnes in 2023 to 3.8 billion tonnes in 2050. Subsequently, proper and effective management of these wastes is essential to mitigate potential threats to the environment and human health (Raphela et al., 2024). In the local context, Malaysia has established several regulations, such as the Environmental Quality Act 1974, to address hazardous waste management (DOE, 2022). However, the challenge remains in the practical enforcement of these regulations due to the lack of awareness amongst workers. Understanding the current practices can help identify potential barriers and gaps in the existing system that hinder the effective management of scheduled waste (Somani, 2023). The Basel Convention defines hazardous waste as a broader term used globally to describe materials that are toxic, reactive, corrosive, flammable, or otherwise harmful to human health and the environment (Korcheva, 2023). This includes a wide range of industrial by-products, such as chemicals, e-waste, heavy metals, or industrial sludge. Meanwhile, scheduled waste is a localised term used in Malaysia's Environmental Quality (Scheduled Wastes) Regulations 2005 to describe a specific waste category that poses unique industrial and environmental challenges within the country (Scheduled Waste Information – Department of Environment, 2005). Both hazardous and scheduled wastes share many common characteristics, including bulbs that contain mercury, Lithium-Ion batteries, and mixed chemicals, all of which can pose significant risks to the environment and public health if not managed properly. Among the potential threats caused by improper disposal of these wastes include severe pollution, biodiversity loss, and long-term health impacts (Somani, 2023).

Many industries struggle with compliance due to insufficient resources and awareness regarding proper waste management practices (Salvia et al., 2021). Previous research indicates that inadequate training for employees involved in waste handling exacerbates these issues, leading to higher exposure risks and potential health problems (Cui et al., 2022). The need for comprehensive training programs that emphasise safety protocols and regulatory compliance is crucial for improving waste management practices (EPA, 2018). This becomes more prominent due to the notable lack of research in identifying the most effective and sustainable methods for managing scheduled waste (Yukalang et al., 2017). Such literary gap can hinder the development of best practices that are tailored to diverse industrial processes, which are crucial for reducing environmental impact and ensuring long-term viability. Research into current waste management practices can provide critical insights into the effectiveness of existing systems (Baumgartner, 2011), revealing gaps in regulatory compliance and areas where enforcement must be strengthened. The majority of existing studies on this topic revolve around the effects of these wastes towards the environment (Chundawat et al., 2024), while overlooking the current practices. Thus, it is vital to provide a snapshot of how waste is handled in real time and reveal the actual processes so that it can be a baseline for future research. It also plays a vital role in safeguarding the safety of workers and communities. This can be done by evaluating measures put in place to minimise exposure to hazardous materials. Understanding how industries handle, store, and dispose of scheduled waste can offer a better comprehension of the complexities and hardships of the practice.

## 3. Materials and Methods

This study adopted a qualitative exploratory approach to investigate scheduled waste management practices in several industrial and academic institutions. The former consisted of a rare earth material producer supporting global manufacturing supply chains and a chemical manufacturing company specialising in acrylic monomers, while the latter was an academic institution engaged in chemical research and handling. The study aims to gain insights into waste handling, regulatory compliance, safety measures, and challenges faced by professionals in the field. It began by identifying the problem statement to establish the research focus, followed by a literature review to provide the research context by exploring existing knowledge and gaps in the field. Next, the parameters—current practices, regulatory compliance, safety measures, and opportunities for improvement—were identified and reviewed to guide the scope of the research. Several key documents, such as academic articles, policy briefs, regulatory guidelines, and case studies from both local and international contexts, were also used to gain further information.

The data collection involved two primary methods. First, a comprehensive document review was conducted and several case studies and articles from the literature review were used to provide a baseline understanding of scheduled waste management practices and inform the development of interview questions. Second, semi-structured interviews were conducted with six experts, comprising two representatives from each of the industrial and academic institutions. These interviews delved into the themes of current practices, regulatory compliance, safety measures, and opportunities for improvement, which are the parameters of the study. Each interview session lasted for one hour and was audio recorded, transcribed verbatim, and anonymised to ensure confidentiality. The interviews were conducted in person at the respective

industrial sites, allowing the respondents to show their actual work environments. All interview items underwent a content validity assessment by several waste management experts to ensure their validity, clarity, and relevance to the topic. These items obtained a Content Validity Index of 0.85, which surpassed the threshold of 0.80 (Gilbert & Prion, 2016). Hence, all items were deemed valid and reliable. The result was then cross-referenced with the document review. The data analysis procedure involved the use of thematic analysis to identify recurring patterns and key themes that align with the four research objectives. These themes were grouped into four categories: waste management practices, safety measures, compliance challenges, and future improvements. Finally, a SWOT analysis was conducted to assess the strengths, weaknesses, opportunities, and threats of current practices. It was supported by relevant literature to ensure its reliability.

**4. Results and Discussion**

The results of this study were derived from qualitative data obtained through interviews with six experts from industrial and academic institutions. These experts consisted of waste managers, health and safety officers, and environmental engineers from the industries. Most of them have a waste management background with more than 5 years of experience. The analysis revealed several key findings across five categories: current practices, regulatory compliance, safety measures, training programs, and future challenges.

**4.1 Type of Waste**

Table 1 shows the various types of scheduled waste across all industries. These wastes were cross-checked with a previous article Scheduled Waste (SW) and Its Sources (2021)) to ensure reliability. These types of waste provide a comprehensive view of how different industries manage scheduled waste, offering valuable insights into best practices and challenges across sectors.

Table 1. Summary of waste generated and scheduled waste code

Industry	Details	Waste Generated (Scheduled Waste Code)
Academic Institution	Focuses on research in chemicals and chemical handling	SW109 Waste containing mercury or its compounds
		SW110 Waste from electrical and electronic assemblies
		SW315 Tar or tarry residues from oil refineries or petrochemical plants
		SW403 Discarded drugs containing psychotropic substances or substances that are toxic, harmful, carcinogenic, mutagenic, or teratogenic
		SW404 Pathogenic wastes, clinical wastes, or quarantined materials
		SW409 Disposed containers, bags, or equipment contaminated with chemicals, pesticides, mineral oil, or scheduled wastes
		SW421 A mixture of scheduled wastes
Industry 1	Producer of rare earth materials for global manufacturing supply chains	SW429 Chemicals that are discarded or off-specification
		SW102 Waste of lead acid batteries in whole or crushed form
		SW103 Waste of batteries containing cadmium, nickel, mercury, or lithium
		SW109 Waste containing mercury or its compounds
		SW204 Sludges containing one or several metals or heavy metals
		SW205 Waste gypsum arising from chemical industries or power plants
		SW311 Waste oil or oily sludge
		SW325 Uncured resin waste containing organic solvents or heavy metals, including epoxy resin and phenolic resin
		SW404 Pathogenic wastes, clinical wastes, or quarantined materials
		SW408 Contaminated soil, debris, or matter from cleaning spills of chemical, mineral oil, or scheduled wastes
		SW409 Disposed containers, bags, or equipment contaminated with chemicals, pesticides, mineral oil, or scheduled wastes
Industry 2	A chemical industry that focuses on acrylic monomers, 2-ethylhexanoic Acid, and OXO products	SW410 Rags, plastics, papers, or filters contaminated with scheduled wastes
		SW429 Chemicals that are discarded or off-specification
		SW204 Sludges containing one or several metals or heavy metals
		SW306 Spent hydraulic oil
		SW322 Waste of non-halogenated organic solvents
		SW403 Discarded drugs containing psychotropic substances or substances that are toxic, harmful, carcinogenic, mutagenic or teratogenic
		SW409 Disposed containers, bags, or equipment contaminated with chemicals, pesticides, mineral oil, or scheduled wastes
SW501 Any residues from treatment or recovery of scheduled wastes		
		SW410 Rags, plastics, papers, or filters contaminated with scheduled wastes
		SW429 Chemicals that are discarded or off-specification

However, this diversity also poses a limitation as it may complicate the process of drawing generalised conclusions, given the industry-specific factors that influence waste management practices. Each industry has various types of scheduled wastes; however, the listed waste types represent those predominantly produced and the most generated by the respective companies. The waste profiles of the three industries depict distinct yet overlapping categories of scheduled waste, which were generated based on their operations.

As shown in Table 1, all three industries generate certain common types of scheduled waste, such as SW409 and SW429. This indicates shared waste management challenges related to chemical residues and containers. The academic institution primarily produces laboratory-related waste (e.g., SW109, SW110, SW315), reflecting its research-focused activities. In contrast, the rare earth material producer and the chemical manufacturing company generate a broader range of industrial wastes, including SW204, SW410, and SW403, which are associated with large-scale chemical processing. Additionally, unique waste codes, such as SW102 and SW103 in the rare earth industry and SW306 and SW322 in the chemical company, highlight industry-specific processes. These findings demonstrate that while there are overlaps in waste types, each industry faces distinct waste management issues based on its operational focus. It shows that each industry generates waste types that directly reflect its core operations, and there is potential to develop sector-specific waste handling guidelines while also streamlining shared protocols for commonly produced waste types.

**4.2 Current Practices**

Industries adhere to SOPs for the handling, storage, and disposal of waste, with SW429 (discarded mixed waste) being the most managed type of waste. Waste treatment is typically outsourced to licensed contractors such as Alam Flora. Additionally, some industries handle their own waste types, including SW205, SW311, SW404, and SW409. For instance, Industry 2 stated that they have their own facilities to handle these waste types. While all these wastes are generally managed according to their SOPs, any scheduled waste showing radioactive readings is first treated by a specialised team rather than merely relying on the core waste management team. This is evidenced in Table 2, whereby all the companies have their own procedural flowcharts that are prominently and clearly displayed near waste storage and waste generated areas. Overall, the waste management processes are organised and systematic.

Table 2. Summary of industries SOPs

Industry	Standard Operating Procedures	Summary of SOPs
Academic Institution	Chemical Waste Management	It outlines general guidelines for the safe handling of chemicals, including the appropriate use of personal protective equipment (PPE), procedures for managing chemical spillages, proper labelling practices, and the correct handling and disposal of chemical waste. The SOPs also provide a detailed flowchart of the chemical waste management process. This includes requirements for waste labelling, inspection of containers for leakage, segregation of chemical waste based on its nature (e.g., acidic, reactive, or alkaline), and proper sealing procedures once containers reach their full capacity.
	Scheduled Waste Management	<ul style="list-style-type: none"> <li>• It includes a detailed procedural flowchart, which is visibly displayed in laboratories.</li> <li>• Assigning specific responsibilities to personnel for identifying waste, determining the correct SW code, and ensuring accurate reporting and documentation.</li> <li>• Use appropriate PPE, applying correct labelling, and ensuring all involved personnel are trained in waste handling, storage, and emergency response.</li> <li>• Waste must be stored in compatible, durable, and leak-proof containers to prevent spills. Incompatible wastes should be separated and placed in designated secondary containment areas designed to hold any accidental releases.</li> <li>• Disposal is conducted either every six months or when waste volume exceeds 20 metric tons, whichever comes first.</li> </ul>
Industry 1	General Waste Management	<ul style="list-style-type: none"> <li>• When waste is generated, waste owner must request empty drums from the waste management team. Requests exceeding ten drums must be made at least 15 days in advance to prevent stock shortages.</li> <li>• The area owner is responsible for labelling the drums appropriately. The original scheduled waste label must not be altered or defaced.</li> <li>• Drums must be placed on a bunded area or a spill pallet to prevent direct contact with the ground.</li> <li>• Drums must remain securely closed and stored under a covered area to prevent exposure to weather.</li> <li>• When a drum is full or reaches 180 days from its generation date, the area owner must contact the waste management team for collection. Prior to collection, the area owner must ensure that the drum is in good condition, properly labelled, and free of any spills.</li> </ul>

Table 2. continued

Industry	Standard Operating Procedures	Summary of SOPs
	Radioactive Waste Management	<ul style="list-style-type: none"> <li>• The SOPs are similar to the general waste management, except after the drum is filled. Before putting it for storage, the drum must be inspected for residual radioactivity. If any traces of radioactive contamination are detected, the drum will be sent to the radioactive waste management team for proper treatment prior to disposal.</li> </ul>
Industry 2	Waste Management	<ul style="list-style-type: none"> <li>• The label must be according to size and clear with no scribble or tear and face outward. It must always refer to the standardised SW names.</li> <li>• The container used to hold the waste must be in good condition (no holes or damages). The waste must be separated by its nature (Acid, Base, Non-compatible)</li> <li>• Any container to be reused must be assigned to specific waste types.</li> <li>• When it is full, the container must be sealed using plastic wrapping, tape, or bands.</li> <li>• A maximum of 4 drums or 1 bag per standard pallet.</li> <li>• Storage must allow space for inspection and fire-fighting access</li> <li>• Scheduled waste must be written/registered on the inventory board before storage.</li> </ul>
	Radioactive Waste Management	<p>The SOPs are similar to the standard waste management but with several key differences:</p> <ul style="list-style-type: none"> <li>• Use a specific type of container that is shielded, leak-proof, and corrosion-resistant.</li> <li>• Containers must be compatible with the type of radioactive material.</li> <li>• When the waste contains any radioactive traces, it will be sent to the radioactive team instead of the waste management team to be treated before it can be disposed.</li> </ul>

**4.3 Regulatory Compliances**

Most companies face a similar challenge in regulatory compliance, which is a lack of awareness among staff regarding the importance of safety practices and SOPs. This can be seen in the academic institution, where Expert 2 stated that most staff sometimes choose to ignore the SOPs as it is easier and does not concern them. It allows them to do the bare minimum and even cut corners by ignoring aspects like PPE and labelling. Industry 1 also faces similar problem at times, as stated by Expert 3. Although most facilities like Industries 1 and 2 enforce compliance through a merit system and impose demerits for non-compliance, some handlers, especially those lacking formal training, may disregard safety briefings and proper waste management practices. This gap in awareness and adherence to regulations poses a risk to maintaining safe and compliant operations. In response, internal and external audits are conducted annually to ensure standards are met. This is also practised at Industries 1 and 2 to reduce non-compliance cases.

**4.4 Safety Measure**

Safety is a core focus in these facilities. PPE, including gloves, lab coats, and shoes, is provided for workers handling scheduled waste. As stated by Expert 5 in Industry 2, all the industries also implement emergency response plans (ERPs) for various emergency scenarios, such as waste spills or hazardous material exposures. Expert 1 in the academic institution further stated that emergency drainage systems are installed to manage spills effectively. This is consistent throughout the three industries during the interview. The only difference is the SOP details. For instance, while the use of drums for waste storage is common in both industries, the academic institution also utilises bins, boxes, and pallets for other waste types, which are reused from old containers of non-hazardous materials. Although these efforts sometimes resulted in minor incidents (e.g., small spills), no major accidents have been recorded. Furthermore, safety protocols, including PPE usage and emergency preparedness, are consistent across all industries, thus contributing to a generally safe working environment. The only difference is the specific PPE used throughout the industry. For example, the use of gloves, masks, safety boots, and goggles is common across all industries, with the addition of coveralls and helmets for Industries 1 and 2.

**4.5 Training and Awareness**

Training in waste management is primarily hands-on, and most workers rely on practical experience rather than formal certifications. As stated by Expert 1, although refresher safety briefings are conducted annually for staff, many employees do not have formal certifications for hazardous waste handling. This is largely due to budget constraints. Expert 6 also stated that training effectiveness is assessed through incident tracking, with revisions made when there is a noticeable rise in accidents. This is consistent across both industries and the academic institution, whereby waste handlers receive on-the-job training, including practical walkthroughs and online safety training sessions. However, the lack of formal certification for hazardous waste handling is identified as a gap in the system (Nguyen et al., 2023).

**4.6 Discussion**

**4.6.1 Investigating the current waste management practices**

The academic institution and both industries follow their own established SOPs for the handling, storage, and disposal of scheduled waste. Commonly managed waste types include SW429, SW109, and SW404. Most facilities rely on licensed contractors, such as Kualiti Alam and Alam Flora, for waste treatment and disposal. While SOPs are well-documented and generally adhered to, inconsistencies arise in areas such as waste separation and documentation, particularly among smaller facilities. The practices observed highlight an operational dependence on external contractors rather than developing in-house treatment capabilities, limiting opportunities for innovation. These practices are also aligned with Chan (2025), who posits that scheduled waste must only be transported by licensed contractors to authorised facilities for treatment or disposal.

**4.6.2 Key challenges identified include:**

Several key challenges were identified in the implementation of chemical waste management practices. One of the main challenges is regulatory awareness. A lack of awareness among certain chemical handlers has led to inconsistent compliance with the established regulations and procedures. This situation may affect the effectiveness of waste handling and increase the risk of improper practices. Another challenge relates to budget constraints. Limited financial resources restrict the organisation’s ability to invest in essential infrastructure, training programmes, and formal certifications that could further strengthen chemical waste management practices.

In addition, infrastructure limitations remain a concern. The availability of temporary waste storage facilities is insufficient to accommodate the increasing volume of chemical waste, creating operational bottlenecks in the waste management process. To mitigate non-compliance issues, some facilities have introduced a merit-based monitoring system, where demerit points are issued for non-compliance. This system has helped reinforce accountability and encourage better adherence to established chemical waste management procedures.

**4.6.3 Examining the safety precautions adopted in the industry to protect workers from hazardous waste exposure**

The safety measures currently put in place include the provision of PPE, such as gloves, lab coats, and protective shoes. All facilities have developed ERPs tailored for spillages and other incidents, supported by emergency drainage systems. Annual training programs and chemical walkabouts are conducted to ensure awareness and preparedness among workers. Despite these measures, the absence of formal certifications for handlers due to budget constraints remains a concern. Minimal incidents, such as minor spillages, indicate that existing safety precautions are generally effective but can be further improved with more comprehensive training.

**4.6.4 Conducting a SWOT analysis to evaluate strengths, weaknesses, opportunities, and threats**

Table 3 shows the SWOT analysis of the research data to establish a comprehensive evaluation of scheduled waste management practices in industries along Malaysia’s East Coast. It serves as a systematic tool to assess both internal and external factors influencing waste management practices.

Table 3. SWOT analysis

Strengths	Weakness
<ul style="list-style-type: none"> <li>• Well-documented SOPs and flowcharts of workflow</li> <li>• PPE is provided</li> <li>• Emergency drainage systems in case of emergency</li> <li>• Big cleaning day to encourage good housekeeping</li> <li>• Outsourcing waste to professionals to ensure proper waste management</li> <li>• Proper ERPs for various scenarios</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of safety awareness amongst staff</li> <li>• Lack of awareness regarding formal certification</li> <li>• Lack of space for the amount of waste generated.</li> <li>• Awkward layout</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• Ensure formal certification training</li> <li>• Renovations of the facilities with better layout and bigger space to accommodate larger waste generated over the years</li> <li>• Increase demand for better-qualified staff who are skilled in chemical handling</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of awareness that disregards safety protocol</li> <li>• Rising waste generated every cycle. With a lack of space, it could be hazardous</li> <li>• Limited space for temporary waste storage for each workstation</li> <li>• Increase the cost of contractors</li> <li>• Stricter regulations, as current regulations do not require waste handlers to have formal certifications to handle scheduled waste</li> </ul>

**5. Conclusions**

The management of scheduled waste is paramount as industrial growth accelerates, with significant implications for both public health and environmental sustainability. This study has provided valuable insights into the current practices, challenges, and safety measures adopted by industries in handling scheduled waste, particularly in the Malaysian coastal

region of Kuantan, Pahang. Despite the existence of well-documented SOPs and safety measures such as PPE and ERPs, there are still gaps in regulatory compliance, safety awareness, and infrastructure limitations. The findings indicate that while many industries comply with basic waste management protocols, several issues remain significant, such as the lack of awareness regarding formal certification among staff, budget constraints, and insufficient infrastructure for temporary waste storage. Although subscribing to external contractors for waste treatment and disposal is both effective and professional, heavy reliance on such services limits the opportunities for innovation and internal capacity building in waste management. The SWOT analysis further underscores these challenges, highlighting the need for formal certification training, enhanced infrastructure, and better-qualified staff. Moreover, the rising volume of waste and the limited space available for its management present ongoing threats that require urgent attention. Addressing these challenges will not only improve regulatory compliance but also ensure a safer working environment and better protection of public health and the environment.

The study's limitations include a small sample size, time constraints, and reliance on qualitative data, which may limit the generalisability of the findings. Despite these challenges, the study provides valuable insight into scheduled waste management practices in the East Coast Regions of Malaysia, contributing to environmental sustainability and public health efforts. In light of these findings, it is recommended for future research to adopt a broader methodological approach that includes quantitative assessments to complement the qualitative insights presented here. This will enable a more comprehensive analysis of waste volumes, compliance trends, and safety incidents, thereby improving generalisability and informing data-driven policymaking. Moreover, future studies should include a wider variety of industrial sectors and geographical regions to reflect the national landscape more accurately. Another area of research that warrants exploration is the effectiveness of formal training and certification in improving staff compliance and safety outcomes. Evaluating training interventions and their impact on waste handling behaviour can offer insights into best practices for workforce development. Additionally, future studies should consider investigating the role of digital and automated technologies—such as IoT-enabled waste tracking and real-time monitoring systems—in enhancing the efficiency, traceability, and accountability of scheduled waste management operations. This study provides a foundational understanding of the current state of scheduled waste management in the East Coast region of Malaysia that could act as a baseline for future investigation. While the findings advocate for the promising nature of the current waste management practices in Malaysia's East Coast, there is considerable room for improvement. Future efforts should focus on raising awareness, enhancing training, investing in infrastructure, and addressing the increasing volume of scheduled waste. These measures are crucial to fostering a sustainable industrial future and minimising the negative impact on both human health and the environment.

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### **Declaration of Competing Interest**

The authors declare no conflicts of interest.

### **CRedit Authorship Contribution Statement**

Afza Humairah (Investigation; Methodology; Validation; Data collection; Writing - original draft)

Mohd Shaiful Zaidi (Writing - review & editing)

Mochammad Sholehuddin (Writing - review & editing)

Azizan Ramli (Conceptualisation; Visualisation; Writing - review & editing)

### **Availability of Data and Materials**

The data supporting this study's findings are available on request from the corresponding author.

### **Ethics Declarations**

This study did not involve human participants or animals. Ethical approval was therefore not required. All subjects gave their informed consent for inclusion before they participated in the study.

### **Generative Artificial Intelligence Declarations**

The authors claim that artificially intelligent-assisted technologies in the form of generative AI were not used to generate content, ideas, or theories. We have just utilised AI to enhance readability and refine the language. This was used with extreme human control and oversight. The authors take full responsibility for reviewing and approving the content.

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