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Literature Review of Workshop Waste Management in Automotive Engineering Education

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ABSTRACT

This study aims to review the condition of waste management of automotive workshops from various empirical studies and assess its implications for automotive engineering education workshops. The problems raised focus on the non-optimal management of B3 waste such as used oil, solvents, batteries, and contaminated fabrics, both in public workshops and educational workshops. The method used is a systematic literature review by analyzing seven valid scientific articles published in the 2022–2025 period and relevant to the topic of automotive workshop waste. The results of the study show that most public workshops still manage waste conventionally without sorting, labeling, standard storage, or cooperation with licensed waste managers. In educational workshops, waste management SOPs are available but have not been implemented consistently, while waste documentation and supervision of student practices are still weak. These findings affirm the need to integrate waste management into the automotive practice curriculum, improve student environmental literacy, provide adequate waste storage facilities, and formalize cooperation with B3 waste managers. This research provides directions for the development of a more systematic and sustainable educational workshop waste management model.

INTRODUCTION

The increase in the number of motor vehicles in Indonesia along with urbanization and economic growth has led to an increase in the need for vehicle maintenance and repair services. Automotive workshops both cars and motorcycles are very important facilities. However, activities routinely carried out in automotive workshops also produce waste, including waste oil, solvents, contaminated fabrics, batteries, and used parts, which are widely classified as Hazardous and Toxic Materials (B3) waste (Deanova et al., 2022; Roto, Rupiwardani, & Yohanan, 2021). If not managed properly, this waste can cause soil, water, and potentially pose health risks to the surrounding environment and workshop workers.

Empirical studies on motorcycle workshops in Malang City show that used oil is often stored in conditions that are not up to standard, and B3 waste management practices in many workshops are still far from ideal (Roto et al., 2021). In large urban areas, such as research conducted in Jakarta and its surroundings, many workshops including small and medium-sized workshops have not implemented waste separation based on characteristics, labeling, proper storage, or waste handover procedures to formal managers (Dahlan, Mursidik, & colleagues,

2023). This kind of condition shows that the automotive workshop sector in Indonesia has serious challenges in managing B3 waste.

In the context of automotive vocational education or practical workshops in educational institutions, this problem becomes more critical. The educational workshop functions not only as a place for technical simulation, but also as a learning environment for prospective technician students. If the waste management practices taught or applied in educational workshops are not up to standard, students can get used to wrong practices, thus instilling bad habits when entering the industrial workforce. Therefore, environmental literacy and B3 waste management competencies need to be integrated into the automotive engineering education curriculum (Widyarsana et al., 2022; Indrawati & Surtikanti, 2022). Recent research in Indonesia also discusses a more comprehensive model of waste management in the workshop not only on used oil and evaluates management practices in automotive workshops and their impact on the environment. The findings show that waste management in many workshops does not meet sustainability standards: key obstacles include lack of technical knowledge, storage infrastructure, and economic incentives to manage waste properly (Ilmi et al., 2025). This raises the urgent need to formulate a systematic, practical, and regulatory model for workshop waste management.

Based on these conditions, it is important to conduct an in-depth literature review of various empirical studies on workshop waste management both in private workshops, MSME workshops, and educational workshops to understand current practices, obstacles, and effective management strategies. This study aims to review the current literature on automotive workshop waste management, identify gaps, and provide recommendations for implementation in the automotive engineering education environment to support safe, efficient, and sustainable workshop practices.

METHODS

This study uses a systematic literature review research design with a qualitative-descriptive approach to identify, evaluate, and synthesize research findings related to waste management in automotive workshops, especially in the context of automotive engineering education. This design was chosen to provide a comprehensive overview of waste management practices, problems faced, and sustainable management strategies recommended by previous studies. The main instrument used in the selection process is a literature identification sheet that contains aspects that must be evaluated, including the purpose of the research, the type of waste studied, the research method, the main findings, and recommendations.

This instrument is used to maintain consistency in assessment between articles and ensure that the data collected is systematic. The data analysis procedure is carried out through three stages. First, the data reduction stage, which is to group each article based on the main theme such as the type of waste, management practices, obstacles, and recommendations. Second, the data presentation stage, which is to compile a summary of findings in the form of a matrix and narrative to facilitate the identification of patterns, similarities, and differences between studies. Third, the conclusion stage, which is to synthesize findings to produce a comprehensive understanding of the condition of workshop waste management and its implications for automotive engineering education. This analytical approach allows researchers to obtain a structured picture of waste management practices and opportunities for more sustainable model development.

RESULTS

The results of the analysis of seven relevant empirical studies show that the waste management of automotive workshops in Indonesia still requires significant improvement, both in terms of sorting, storage, documentation, and final handling of waste. The literature also emphasizes that the characteristics of automotive workshop waste classified as B3 require strict management standards. The discussion was divided into four main themes: (1) the characteristics of waste and its sources, (2) waste management practices in public workshops and education, (3) implementation barriers, and (4)

implications for automotive engineering education.

Table 1
Matriks Review Literature

Researcher & Year	Research Location	Key Findings	Research Recommendations
Roto, Rupiwardani & Yohanan (2022)	Malang – MSME Motorcycle Workshop	The majority of workshops store used oil in open containers; management has not been in accordance with B3 standards	Technician training, provision of closed storage containers, implementation of waste SOPs
Mahardika, Santoso & Wijaya (2022)	Surakarta – Motorcycle Workshop	Used oil contains Pb & Cu above the threshold; Waste Not Sorted	Waste separation, use of B3 special containers, internal control of waste quality
Deanova et al. (2022)	Surakarta – Industrial Workshop	Workshop waste consists of oil, solvents, batteries, contaminated fabrics; Mostly unseparated	Standardization of waste sorting, B3 labeling, improvement of storage facilities
Wardana et al. (2025)	North Samarinda – Unofficial Motorcycle Workshop	Used oil is dominant; waste is not labeled; Unsafe containers	Technician education, tight storage facilities, simple SOPs for small workshops
Indrawati & Surtikanti (2024)	Bandung – Small Car Workshop	There is no cooperation with licensed waste managers; Waste not recorded	B3 regulatory development, waste labeling, cooperation with licensed managers
Gunawan et al. (2024)	Palangka Raya – MSMEs Surya Makmur Motor	Simple distillation technology is able to process used oil into recycled oil	Application of distillation in educational workshops as an environmental innovation practice
Ilmi, Muflihat & Baharuddin (2025)	Makassar – Campus Education Workshop	Waste management has not been integrated into the campus system; Inconsistent SOPs	Integration of waste management into curriculum, periodic audits, improvement of B3 facilities

DISCUSSION

1. Characteristics of Waste and Its Sources

The review shows that automotive workshops produce similar B3 waste, regardless of the scale of their business. The study of Deanova et al. (2022) identified that automotive workshops produce waste in the form of used oil, solvents, used batteries, metal powders, and contaminated cleaning cloths. In line with that, Mahardika et al. (2022) said that used oil is the waste with the largest volume and contains heavy metals such as Pb and Cu in high concentrations. At an MSME motorcycle workshop in Malang City, Roto et al. (2022) found that waste oil is disposed of without proper separation or security, so it has the potential to pollute soil and water. Meanwhile, a study by Ilmi et al. (2025) focusing on educational workshops noted that the type of waste produced is no different from industrial workshops, but the management

system has not been integrated into campus environmental management policies.

2. Waste Management Practices in Public and Education Workshops

Field studies show that B3 waste management practices in public workshops still tend to be conventional and do not meet standards. Wardana et al. (2025) found that unofficial workshops in Samarinda accommodate used oil in unlabeled and non-impermeable containers, and do not separate hazardous waste. Tungka et al. (2023) corroborate this finding by showing that motor vehicle workshops in Minahasa still dispose of waste without proper management, including direct disposal into the soil and waterways.

In small car repair shops, Indrawati and Surtikanti (2024) identified that most workshops do not have waste storage in accordance with B3 standards, and have not cooperated with licensed waste managers. These results show that waste management practices and workshop owners' understanding of regulations are still low. In the context of education, Ilmi et al. (2025) show that although SOP tools are available, their implementation has not been consistent. Many educational workshops have not recorded waste generation, systematic sorting, and student training on waste safety and management.

3. Obstacles to Waste Management Implementation

The literature reveals three main obstacles in the management of automotive workshop waste:

a. Technician and student knowledge is still limited

Wardana et al. (2025) highlight that unofficial workshop technicians do not yet understand the dangers of B3 waste, including the risk of contamination from waste oil. Ilmi et al. (2025) added that automotive engineering students still lack environmental literacy so they are not used to separating and handling waste independently.

b. Lack of waste management facilities and infrastructure

Many workshops, especially MSMEs, do not provide special storage places for B3 waste. Roto et al. (2022) and Tungka et al. (2023) show that waste oil is generally only stored in makeshift containers. In fact, Gunawan et al. (2024) show that small-scale workshops often dispose of waste oil carelessly because they do not have basic facilities and do not see the economic value of the waste.

c. Absence of SOPs or consistent supervision

Both public workshops and educational workshops have not implemented SOPs strictly. Ilmi et al. (2025) emphasized that without consistently implemented SOPs, waste management systems do not run as they should even though facilities are available.

4. Implications for Automotive Engineering Education

Literature results show that poor waste management in educational workshops can reduce the quality of learning and form bad habits in students. Because students view educational workshops as simulations of a real work environment, waste handling practices that do not meet standards have a direct impact on their work readiness. Ilmi et al. (2025) emphasized the need to integrate waste management into the practice curriculum, including periodic environmental audits, the use of strict SOPs, occupational safety training, and cooperation with licensed B3 waste managers. In addition, the findings of Gunawan et al. (2024) regarding the innovation of used oil processing through simple distillation can also be an alternative to learning environment-based projects in educational workshops.

Overall, improving the quality of waste management in automotive engineering education workshops is an important step to form prospective technicians who are not only technically competent, but also responsible and oriented towards environmental sustainability.

CONCLUSION

A literature review shows that waste management in automotive workshops still does not meet environmental standards, both in public workshops and educational workshops. The dominant waste in the form of used oil and contaminated materials has not been separated and has not been stored according to the B3 standard. Education workshops have better potential, but the

implementation of SOPs and supervision of student practices is still not optimal.

To improve the quality of waste management in educational workshops, it is necessary to integrate waste management into the curriculum, improve B3 waste storage facilities, regular training for students and instructors, and cooperate with licensed waste managers. Thus, educational workshops can be a model of good waste management and form prospective automotive technicians who are competent and environmentally friendly.

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