LAPORAN PUBLIKASI
ARTIKEL JURNAL NASIONAL TERAKREDITASI SINTA 1/ TERINDEKS SCOPUS Q4

SUSTAINABLE OCCUPATIONAL SAFETY AND HEALTH FOR THE ENVIRONMENT AND EDUCATION-BASED WASTE MANAGEMENT CENTER IN BANYUMAS, Indonesia

https://e-journal.unair.ac.id/JKL/article/view/88699

Dian Mardi Safitri[1,2*], Anik Nur Habyba[1,5], Winnie Septiani[1,2], Nora Azmi[1,2], Bambang Tri Wardoyo[2,3], Toru Matsumoto[4]

1Industrial Engineering Department, Faculty of Industrial Technology, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[2]Center of Excellence for Ergonomics, Occupational Health, and Safety, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[3]Visual Communication Design Department, Faculty of Art and Design, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[4]Institute of Environmental Science and Technology, The University of Kitakyushu, Fukuoka 808-0135, Japan
[5]Department of Industrial Engineering and Management, Yuan Ze University, Taoyuan City 32003, Taiwan

Jurnal Kesehatan Lingkungan
Special Issue | Vol. 18 No. 1si
DOI: 10.20473/jkl.v18i1si.2026.129-137
ISSN: 1829 - 7285 | E-ISSN: 2040 - 881X

Jurnal Kesehatan Lingkungan

Quartile

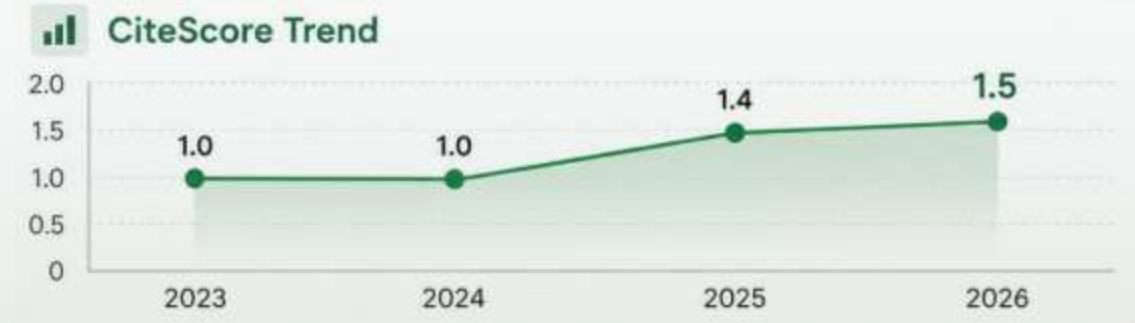
Q3

CiteScore 2026

1.5

Category

Public Health, Environmental and Occupational Health

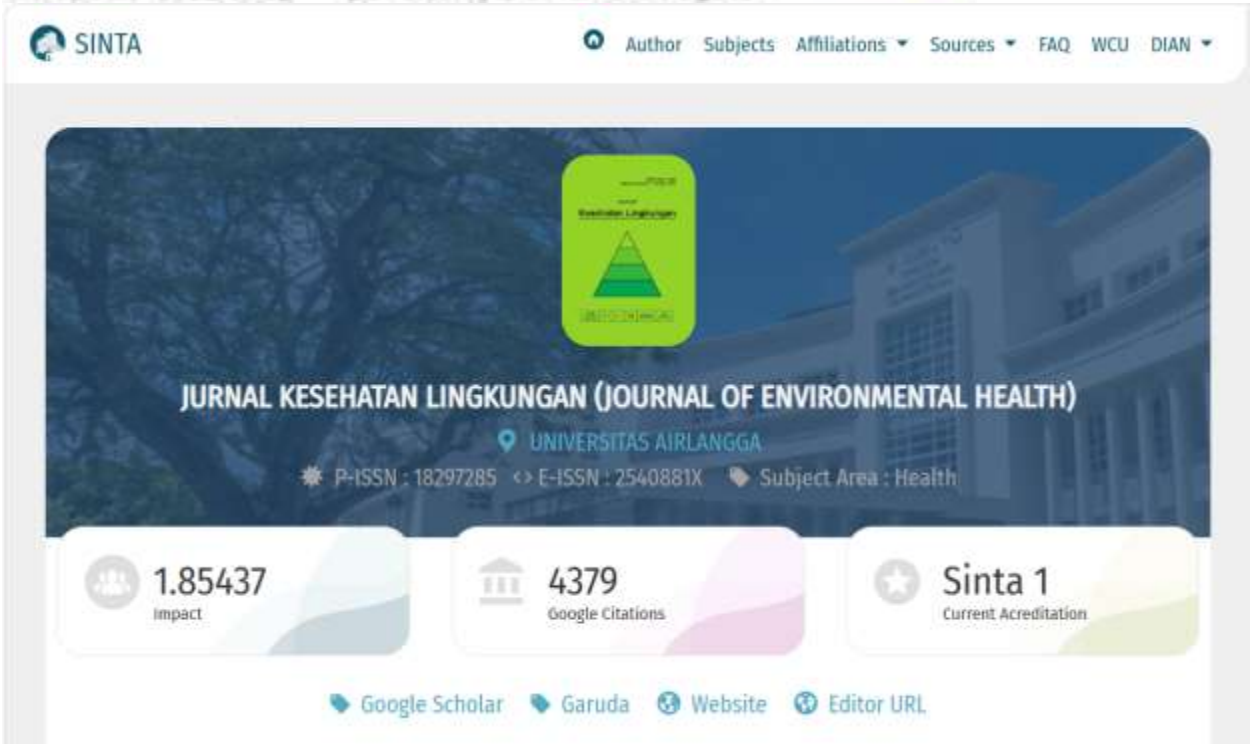


Scopus

Indexed in Scopus
Data sourced from Scopus

View on Scopus


JURNAL KESEHATAN LINGKUNGAN
(Journal of Environmental Health)
S1
H-INDEX : 29
H5-INDEX : 27


SINTA
Author
Subjects
Affiliations
Sources
FAQ
WCU
DIAN
JURNAL KESEHATAN LINGKUNGAN (JOURNAL OF ENVIRONMENTAL HEALTH)
UNIVERSITAS AIRLANGGA
P-ISSN : 18297285
E-ISSN : 2540881X
Subject Area : Health
1.85437
Impact
4379
Google Citations
Sinta 1
Current Acreditation
Google Scholar
Garuda
Website
Editor URL

Editorial Team

Public Health Faculty, Universitas Airlangga, Indonesia

0000-0001-8792-676X
Nafi'atul Irbah
59257151200
--

Reviewers

Reviewers

Dr. Siwi Pratama Mars Wijayanti ,S.Si., M.Kes., Ph.D
Reviewers
Department of Public Health, Faculty of Health Sciences, Jenderal Soedirman University, Indonesia

0000-0002-9227-4599
Siwi Pramatama Mars Wijayanti
57188709069
5976278

Dr. Mela Firdaust, M.KL, S.ST
Reviewers
Department of Public Health, Politeknik Kesehatan Kementerian Kesehatan Semarang, Indonesia

0000-0003-4751-0078
Mela Firdaust
-
5983929

Kusuma Scorpia Lestari, dr., M.KM
Reviewers
Department of Health Environment Faculty of Public Health, Universitas Airlangga, Indonesia

0000-0001-9450-2543
Kusuma S. Lestari
57203165510
6007746

Kahar S.KM., M.KL
Reviewers
Environmental Health Study Program, Politeknik Kesehatan Kementerian Kesehatan Bandung, Indonesia

0000-0002-5669-0253
Kahar Kahar
-
-

Dr. Suratman Suratman
Reviewers
Department of Public Health, Faculty of Health Sciences, Jenderal Soedirman University, Purwokerto, Indonesia, Indonesia

0000-0003-2605-2880
Suratman Suratman

56572984500
5975407

Dr. Triska Susila Nindya, SKM. MPH
Reviewers
Department of Nutrition, Faculty of Public Health, Universitas Airlangga, Indonesia

0000-0003-0870-5630
triska susila nindya
57189907442
6055131

Prof. Dr. Ir. Mursid Raharjo, M. Si
Reviewers
Department of Environmental Health, Faculty of Public Health, Universitas Diponegoro, Indonesia

0000-0003-4791-1242
Dr.Ir.Mursid Raharjo,M.Si
57202013506
6067622

Dr. dr. Taufik Ashar, MKM
Reviewers
Faculty of Public Health, Universitas Sumatra Utara, Indonesia

0000-0002-3211-2328
taufik ashar
5718870547
6019413

Dr. Agus Bintara Birawida, M.Kes
Reviewers
Faculty of Public Health, Universitas Hasanuddin, Indonesia

0000-0002-8223-2387
Agus Bintara Birawida
57193116626
6023654

Dr. Normala Ibrahim MV Bch BAO, MMed (Psych), PhD
Reviewers
Department of Psychiatry, Faculty of Medicine &Health Science, Universiti Putra Malaysia, Malaysia

0000-0003-2868-9834
Normala Ibrahim
54414227000
-

Dina Fitriana Rosyada, S.KM., M.KL
Reviewers

Vocational College of Universitas Gadjah Mada, Indonesia

-
Dina Fitriana Rosyada
-
6066053

Prof. Dr. Santi Martini, dr., M.Kes
Reviewers
Department of Epidemiology, Faculty of Public Health, Universitas Airlangga, Indonesia

0000-0003-2424-1776
Santi Martini
57162600900
6025391

Dr. Corie Indria Prasasti, S.KM., M.Kes
Reviewers
Department of Environmental Health, Faculty of Public Health, Universitas Airlangga, Indonesia

0000-0003-4384-9162
Corie Indria Prasasti
57194592642
5999260

Adhi Yuniarto, ST., MT., Ph.D
Reviewers
Environmental Technic of Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

0000-0002-7492-6901
Adhi Yuniarto
36988240400
29653

Mr. Mursyidul Ibad S.KM., M.KL
Reviewers
Universitas Nahdhatul Ulama Surabaya, Indonesia

0000-0002-9227-7546
Mursyidul Ibad
57218764581
6730877

Leli Indahwati, ST., M. KL
Reviewers
Technical Centre for Environmental Health and Disease Control of Surabaya, Indonesia

Inoy Trisnaini, SKM., MKL
Reviewers
at Public Health, Universitas Sriwijaya, Indonesia

0000-0002-8675-1598
Inoy Trisnaini
57205020676
6093697

Dr. Yudied Agung Mirasa, SKM., M.Kes
Reviewers
Technical Centre for Environmental Health and Disease Control of Surabaya, Indonesia

0000-0003-0636-9063
Yudied Agung Mirasa
57212659232
6734456

Dr. Moch. Irfan Hadi, S.KM., M.Kes
Reviewers
Faculty of Psychology and Health Science, Universitas Islam Negeri Sunan Ampel Surabaya, Indonesia

0000-0001-8725-4836
Moch Irfan Hadi
57218139510
6001306

dr. Rudy Joegijantoro, MMRS
Reviewers
STIKes Widyagama Husada, Indonesia

0000-0001-8541-0954
Rudy Joegijantoro
57189242151
6646893

Abdul Hakim Zakkiy Fasya, S.KM., M.KL
Reviewers
Universitas Nahdatul Ulama, Indonesia

0000-0002-8171-5491
Abdul Hakim Zakkiy Fasya
57218354514
6695810

Ratnaningtyas Wahyu Kusuma Wardani, S.KM., M.KL
Reviewers
Vocational Faculty, Universitas Airlangga, Indonesia

0000-0002-2743-7232
Ratnaningtyas Wahyu Kusuma Wardani, M.KL
57219960677

6749512

Edza Aria Wikurendra, S.KM., M.KL., PhD
Reviewers
Magyar Agrár- és í‰lettudományi Egyetem, Kaposvári, Hungary

0000-0002-5020-375X
Edza Aria Wikurendra
57225988981
6679133

Assoc. Prof. Dr. Supaporn Chaigarun
Reviewers
Ubon Ratchathani Rajabhat University, Thailand

-50861236000
-

Ir. Setyo Budi Kurniawan, S.T., M.T., M.B.A., Ph.D
Reviewers
Institute of Microbiology, The Czech Academy Sciences, Czech Republic

0002-0791-1638
Setyo Budi Kurniawan
57197845231

Prof. Ts. Dr. Zainul Amiruddin Zakaria
Reviewers
Department of Biomedica Sciences, Faculty of Medicine and Health Sciences, Universiti Malaysia Sabah, Malaysia

0001-5525-7821
Prof. Ts. Dr. Zainul Amiruddin Zakaria
9235660400
-

Prof. Firdaus Mohamad Hamzah, Ph.D
Reviewers
Department of Civil and Structural Engineering, Universiti Kebangsaan Malaysia, Malaysia

0002-6750-6183
Firdaus Mohamad Hamzah
56266163500
-

Prof. Dr. Mohd. Talib Latif
Reviewers
Department of Earth Sciences and Environment, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, Malaysia

0003-2339-3321

Mohd Talib Latif
57218373467
-

Prof. Jean Louis Roubaty, Ph.D., Dr. Sc.
Reviewers
Environmental Engineering Paris-Diderot University, France

-
-
6507232439
-

Dr. R. Azizah, SH., M.Kes.
Reviewers
Environmental Health Department, Faculty of Public Health, Universitas Airlangga, Indonesia

0000-0002-6741-5572
Assoc. Prof. Dr. R. Azizah, S.H., M.Kes
56362440000
6055508

Muyassar Hamid Abualreesh, Ph.D.
Reviewers
Marine Biology Department, Faculty of Marine Sciences, King Abdulaziz University (KAU), Ministry of Education Kingdom of Saudi Arabia

0000-0003-3170-3609
Muyassar H. Abualreesh
57214728249

Participants

- Zida Husnina, S.KM, M.PH (zidajkl)
- Dian (dianmardi)

Messages

Note	From
Dear Author, Please find attached the initial reviewer comments (GFA) for your article. We kindly ask you to revise your manuscript in accordance with the provided comments. The revised manuscript should be submitted no later than **April 10, 2026**. We would greatly appreciate your timely response in order to ensure an efficient review and publication process. Thank you for your cooperation. Best regards, Assistant Editor - *Jurnal Kesehatan Lingkungan* 88699_Safitri_GFA1.docx	zidajkl 2026-04-03 06:01 PM
Dear Author, We would like to inform you that there is a recent policy update regarding the Special Issue. For this edition, a proofreading certificate is no longer required. However, please ensure that the manuscript is written in clear and proper English, with correct grammar and in accordance with standard academic writing conventions. Thank you for your attention and cooperation. Best regards, Assistant Editor - *Jurnal Kesehatan Lingkungan*	zidajkl 2026-04-04 10:27 PM
Settings Dear Editor, Dear Editor, We would like to express our sincere appreciation for the time and effort you and the reviewers have dedicated to evaluating our manuscript entitled: **“Sustainable Occupational Safety and Health for the Environment and Education-Based Waste Management Center in Banyumas, Indonesia.”**	dianmardi 2026-04-11 03:47 AM

Note	From
We are pleased to submit the revised version of our manuscript for your consideration. We hope that the revised manuscript is now suitable for publication in your esteemed journal. Thank you for your consideration, and we look forward to your feedback. Sincerely, Dian Mardi Safitri 88699_Safitri_GFA1 rev 1 10-4-26.docx Turnitin - SUSTAINABLE OCCUPATIONAL SAFETY AND HEALTH FOR THE ENVIRONMENT AND EDUCATION-BASED WASTE MANAGEMENT CENTER IN BANYUMAS, INDONESIA (1).pdf Copyright Transfer Agreement - Jurnal Kesehatan Lingkungan.docx Conflict of Interest - Jurnal Kesehatan Lingkungan.docx	
Dear Author, Please find attached the initial reviewer comments **(GFA) 2** for your article. We kindly ask you to revise your manuscript in accordance with the provided comments. The revised manuscript should be submitted no later than **April 17, 2026**. We would greatly appreciate your timely response in order to ensure an efficient review and publication process. Thank you for your cooperation. Best regards, Assistant Editor - *Jurnal Kesehatan Lingkungan* 88699_Safitri_GFA2.docx	zidajkl 2026-04-12 02:49 PM
Settings Dear Editor, I am sending the revised second round of our article. I apologize for the delay, which is due to my health condition. The ethical approval document is still in progress with the Universitas Trisakti SIMETIK application, so I will need more time to complete it. I hope you can consider this situation. Thank you. Regards, Dian Mardi Safitri 88699_Safitri_GFA2 - rev.docx	dianmardi 2026-04-22 06:15 PM
Settings Dear Editor, I re-send the updated GFA2 file in the attachment. Thank you. Regards,	dianmardi 2026-04-24 07:09 AM

Note	From
Dian Mardi Safitri 88699_Safitri_GFA2 - rev.docx	

Review Discussion

×Close Panel

Participants

- Zida Husnina, S.KM, M.PH (zidajkl)
- Dian (dianmardi)

Messages

Note	From
Dear Author, Here is the feedback from the **Reviewer.** Please check this out and revise it optimally. Turn on **the 'TRACK AND CHANGES'** feature on your manuscript before you start revising. **Make sure to address every comment from the reviewer in a table of responses in a separate file (.doc)**. Thank you **Deadline : 9 May 2026** 88699_Review.docx 88699_Reviewer's Comments.docx Example_Table of Response.docx	zidajkl 2026-05-04 03:14 PM
Settings Dear Editor, I am pleased to submit the revised manuscript along with the table of responses for your review. Thank you. Regards, Dian Mardi Safitri 88699_Reviewer's+Comments rev 1.docx Table+of+Response rev 1.docx	dianmardi 2026-05-08 04:46 PM

Article ID - Title : 88699 - SUSTAINABLE OCCUPATIONAL SAFETY AND HEALTH FOR THE ENVIRONMENT AND EDUCATION-BASED WASTE MANAGEMENT CENTER IN BANYUMAS, INDONESIA

Revision Date : May 9, 2026

REVIEW A Comments	Revision
clearly explain what the unit of analysis is here, who the sample or informants are	Line 106 The unit analysis is the integrated waste management system, specifically at the Environment and Education-based Waste Management Center in Banyumas Regency, Central Java, Indonesia. This study utilized a variety of informants and data sources to gather qualitative and quantitative information. The interview participants are 8, including the supervisor and waste workers.
explain what parameters are used	Line 147 This study identifies the core sustainability parameters used to identify the consequences and impact of various hazards as environmental parameters that focus on ecological integrity and the mitigation of risk like air pollution and hazardous substance exposure, economic parameters relating to operational efficiency, productivity, and the advancement of the circular economy, and social parameters emphasizing worker health, safety, and well-being.
explain the study limitations	Line 330 This study has some limitations. First, it uses a single-case design, which may limit the generalizability of the findings to other waste management contexts. Additionally, there is a lack of long-term exposure monitoring and health outcome data, which prevents us from determining a clear causal relationship between the identified environmental stressors and specific occupational health effects.

Final Editorial Check

Participants

- Zida Husnina, S.KM, M.PH (zidajkl)
- Dian (dianmardi)

Messages

Note	From
Dear Author, We would like to inform you that the **final check of your manuscript** has been completed. Please **revise your article based on the comments provided**, and make all corrections **directly in the file that was sent to you**. The deadline for submitting the revised version is **15 May 2026**. Kindly ensure that all suggested revisions are addressed before resubmission. Thank you for your attention and cooperation. Best regards, Assistant Editor - *Jurnal Kesehatan Lingkungan* 88699_Safitri_Final Check.docx 88699_Turnitin AI.pdf	zidajkl 2026-05-10 10:36 PM
Settings Dear Editor, Enclosed is the revised manuscript. Thank you. Regards, Dian Mardi Safitri 88699_Safitri_Final+Check rev 17-5-26.docx	dianmardi 2026-05-19 07:53 AM
Dear Author, Please find attached the invoice for the Article Processing Charge (APC) for your manuscript. After completing the payment, please send your proof of payment to jkesling@fkm.unair.ac.id for verification. The Letter of Acceptance (LoA) will be issued after payment confirmation. Best regards, Assistant Editor - *Jurnal Kesehatan Lingkungan* 018_APC_SI_Dian Mardi Safitri.pdf	zidajkl 2026-05-19 09:47 AM

Jurnal Kesehatan Lingkungan
Journal of Environmental Health
Special Issue | Vol. 18 No. 1si
DOI: 10.20473/jkl.v18i1si.2026.129-137
ISSN: 1829 - 7285 | E-ISSN: 2040 - 881X
Journal Home Page: https://e-journal.unair.ac.id/JKL
ORIGINAL RESEARCH Open Access

SUSTAINABLE OCCUPATIONAL SAFETY AND HEALTH FOR THE ENVIRONMENT AND EDUCATION-BASED WASTE MANAGEMENT CENTER IN BANYUMAS, INDONESIA

Dian Mardi Safitri[1,2*], Anik Nur Habyba[1,5], Winnie Septiani[1,2], Nora Azmi[1,2], Bambang Tri Wardoyo[2,3], Toru Matsumoto[4]

[1]Industrial Engineering Department, Faculty of Industrial Technology, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[2]Center of Excellence for Ergonomics, Occupational Health, and Safety, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[3]Visual Communication Design Department, Faculty of Art and Design, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[4]Institute of Environmental Science and Technology, The University of Kitakyushu, Fukuoka 808-0135, Japan
[5]Department of Industrial Engineering and Management, Yuan Ze University, Taoyuan City 32003, Taiwan

Corresponding Author:
*) dianm@trisakti.ac.id

Article Info

Submitted	: 3 March 2026
In reviewed	: 29 April 2026
Accepted	: 19 May 2026
Available Online	: 30 June 2026

Keywords : *Hazard Identification Risk Assessment and Risk Control, Lean Safety, Safety Culture, Sustainable Occupational Safety and Health, Waste Management*

Published by *Faculty of Public Health Universitas Airlangga*

Abstract

Introduction: *Worker in integrated waste processing facilities are exposed to a range of environmental health stressor from machinery processing, human, and organizational processes. This study aims to develop a sustainable occupational safety and health (OSH) model for an environment and education based waste management center (TPA-BLE) in Banyumas, Indonesia.* ***Methods:*** *A mixed-method approach was used combining field observation, environmental measurements, qualitative risk assessment, and stakeholder consultation. The Hazard Identification, Risk Assessment, and Risk Control (HIRARC) framework was used to systematically identify hazards and assess the risks in environmental, human, equipment, and organizational aspects. The risk control strategies were integrating Lean Safety principles and the 5S Cycle to reinforce sustainability and continuous improvement.* ***Results and Discussion:*** *Finding shows worker are exposed to high-risk health stressor such as noise, airborne particulates, heat, ergonomic strain, and hazardous emission, compounded by the organizational and behavioral factors. The Lean-Safety HIRARC model combines the hierarchy of controls with continuous improvement to improve worker protection and operational sustainability. The integrated approach reframes waste management center as an essential environmental health site that free from the OSH issue.* ***Conclusion:*** *The study proposes a new Lean Safety-HIRARC model as a continuous improvement framework. The findings highlight a practical, policy-relevant framework for strengthening environmental and occupational health performance in waste management systems in developing countries.*

INTRODUCTION

The quality of life for workers serves as a key indicator for realizing SDG 3, which focuses on health and well-being SDG 8, which emphasizes decent work and economic growth; and SDG 11 (1). Workers in waste management face four primary hazards: environmental, human, operational, and organizational factors. The challenges of waste management, exacerbated by population growth, represent a significant issue for urban areas today. Effective waste management has profound implications for individuals' lives, the environment, the economy, and public health. Waste management poses significant challenges to worker health and environmental integrity (2). Disposing waste materials by burying them

Cite this as :
Safitri DM, Habyba AN, Septiani W, Azmi N, Wardoyo BT, Matsumoto T. Sustainable Occupational Safety and Health for the Environment and Education-Based Waste Management Center in Banyumas, Indonesia. *Jurnal Kesehatan Lingkungan*. 2026;18(1si):129-137. https://doi.org/10.20473/jkl.v18i1si.2026.129-137

into designated areas of land, collecting waste in open area, sorting and processing hazards to the employees and harm the environment due to the contamination (3). The health risks must be understood to build a strategy that is safer and more effective (4). There are some potential hazards to the worker healthiness especially from inhalation or skin exposure from pollutants (5). The prior observation at one of the Waste Bank in Depok, West Java and in Banyumas was carried out to find all the evidence of hazards and strengthen the findings from literature review.

In Central Java, especially in Banyumas, there is a Waste Management Center built as an environmental and education-based waste management facility. It is mentioned as TPA-BLE Waste Management Center. It serves as a modern and integrated waste management, supporting the circular economy. The TPA-BLE has been built to manage and reduce the waste comes from community in Banyumas residence. TPA-BLE has a land area of 3.5 hectares and has a processing capacity of up to 75 tons/day to minimize the landfilling activities, promoting the awareness of transforming the waste into value, educate people to sort household garbage before it was sent to the temporary waste drop center. The educational role of the waste bank plays a significant contribution to make the community literate about the waste management and how to support sustainability.

These issues highlight the urgency of strengthening occupational health and safety governance and cultivating a robust safety system. Environmental factors include inadequate lighting, high-intensity noise exposure reaching 90dB for 6-8 hours per day, smoke pollution from burning, and exposure to hazardous materials from community waste in a mixed state (6). Human factors include unnatural working postures, workers' health and fitness, mental burden, and psychological and behavioral aspects such as safety participation, knowledge, behavior, motivation, and awareness (7). Work tool factors include the use of machines and hand tools in waste processing and management, while organizational factors include safety climate, safety policy, and safety culture (8). The second section presents the consequences of occupational diseases, work-related diseases, and work accidents. The last section highlights long-term impacts, such as improving quality of life, environmental sustainability, and contributing to decent work and economic growth (SDG 8).

OHS problems in waste management operations require intervention in environmental, human, work equipment, and organizational factors. The Lean safety approach serves as the basis for this research to address OHS problems in waste management (9). Lean Safety is a lean-thinking management approach focusing on safety. This approach is suitable for improving safety because it requires a proactive stance and greater human involvement to foster a safety culture and climate. The four hazard factors in the preliminary study human, organizational, work equipment, and environmental require holistic safety management. The Lean safety framework will manage the hazard identification, risk analysis, and risk control (HIRARC) process sustainably through the Sort (sorting), Set in Order (arranging), Shine (cleaning), Standardize (standardizing the process), and Sustain (maintaining) cycle (10).

The problem-solving approach is divided into three main parts: Hazard Identification, Risk Analysis, and Risk Control (11). The first stage, Hazard Identification, includes two main steps: "Situation Analysis and Problem Identification" and "Task Analysis of Waste Management." This step involves identifying hazards from the environment, work equipment, people, and organizations. The second stage, Risk Analysis, includes analyzing the risk levels for various hazards: environmental, human, work equipment, and organizational. Each type of hazard is examined to determine its consequences and impacts. The third stage, Risk Control, includes two sub-sections: Lean Safety Program Design and Safety Standard, Safety Policy Design.

The first sub-section describes the risk control hierarchy, starting with hazard elimination, hazard substitution, isolation (limiting human access to the source of danger), engineering controls (work system design), and the use of personal protective equipment (PPE). The second sub-section covers the 5S (Sort, Set in Order, Shine, Standardize, Sustain) steps and control standards for various hazards (environment, people, work tools, and organization) (12). This is a comprehensive approach to sustainable occupational safety risk control that ensures a safe and healthy work environment (13). A systematic and structured approach to identifying, analyzing, and controlling risks, which is used as a basis for improving occupational safety. This research is novel in its application of Lean Safety and HIRARC concepts to improve sustainable occupational safety and health. Comparisons with the literature are used to demonstrate the position and novelty of this research.

METHODS

This study adopts a mixed-method approach integrating qualitative field observation, quantitative risk assessment, and participatory evaluation to develop a sustainable occupational safety and health model for waste management systems. The unit analysis is the

integrated waste management system, specifically at the Environment and Education-based Waste Management Center in Banyumas Regency, Central Java, Indonesia. The study involves differs respondent as principal data source. Eight respondents were invited, including supervisor, and the workers of sorting, burning, and paving block production.

The research methodology integrates the HIRARC (Hazar Identification, Risk Assessment and Risk Control) framework, with the Kaizen lean principles that consist of 5S Cycle (Sort, Set in Order, Shine, Standardize and Sustain). The HIRARC was implemented as a framework for Occupational Health and Safety mitigation, while the Lean concept support and ensure the health and safety culture that comes from HIRARC process.

This study utilized a variety of informants and data sources to gather qualitative and quantitative information. The interview participants are 8, including the supervisor and waste workers. The methodological foundation combines the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) framework with the lean philosophy and the 5S Cycle (Sort, Set in Order, Shine, Standardize, Sustain) to embed risk management within continuous improvement practices. The choice of TPA-BLE Banyumas as the study site is grounded in its strategic importance as a regional model for integrated waste management, showcasing both technical innovation and the persistent challenge of ensuring sustainable and safe operations.

The initial phase of HIRARC is hazard identification. The hazards identified include human hazard, environment, work tools and organization. Literature review and field observation were done to identify all of these hazards. Furthermore, the consequences and impacts of each source of danger are identified on the sustainability pillars (environment, economy, and social). This is done by collecting data on undesirable events as evidence. The next stage is risk analysis and assessment. This assessment includes the severity of the impact and the likelihood or probability of its occurrence. Based on the risk analysis results, the priority of risk control efforts is determined using the hierarchy of controls, which includes elimination, substitution, isolation, engineering controls, and personal protective equipment (PPE). Then, a lean safety program is designed using the 5S strategy (Sort, Set in Order, Shine, Standardize, Sustain) to create a safer, more efficient work environment.

The design of Safety Standards and Safety Policies is also carried out to establish the required safety standards. In hazard identification, potential hazards were categorized into four domains: environmental, human, tool (equipment), and organizational factors. Then, in the risk assessment, each identified hazard was evaluated based on its likelihood, frequency, and severity of consequences. Finally, in the risk control, hazards were prioritized for control planning, and the evaluation process included worker participation to ensure contextual understanding of operational hazards.

The approach of lean safety plays a critical role by serving a bridge between strategy recommendation and the safety culture cycle development. The lean safety ensures the improvements are aligned with operational efficiency, hazard elimination, and worker participation. The lean safety approach was integrated to align safety improvement with operational efficiency, emphasizing hazard elimination, error-proofing, and worker empowerment. The 5S was used as the operational mechanism to embed safety culture and discipline in daily practices: Sort: Identify and remove non-value adding items, creating hazards; Set in Order: Organize tools and materials ergonomically for safety and efficiency; Shine: Maintain cleanliness to prevent contamination and early detect unsafe conditions; Standardized: Develop clear and consistent work standards and inspection routines; and Sustain: Reinforce safety culture through habit formation, discipline, and continuous learning. Each dimension was systematically mapped to the hierarchy of controls (elimination, substitution, engineering, administrative, and PPE), resulting in a structured, measurable improvement matrix.

The results were synthesized into the Lean Safety-HIRARC Model, which integrates the risk hierarchy, 5S discipline, and continuous improvement. The model was validated through expert review (practitioners and academics) to ensure relevance, feasibility, and sustainability. This study identifies the core sustainability parameters used to identify the consequences and impact of various hazards as environmental parameters that focus on ecological integrity and the mitigation of risk like air pollution and hazardous substance exposure, economic parameters relating to operational efficiency, productivity, and the advancement of the circular economy, and social parameters emphasizing worker health, safety, and well-being.

RESULTS

As assessment of workplace hazard was concerning on some occupational risk, spanning multiple categories. The worker their faces environmental danger, human factor problems, equipment-related threats, and organizational shortcomings. The majorities of these hazards classified as high risk. Human-related factors constitute another significant concern, especially

in worker behavior and physiology. Awkward posture dominates their working movement. Most notably, personal protective equipment (PPE) adoption remains inconsistent across the facilities. Conveyor belts, shredders and extrudes present entrapment risk along the possibilities of laceration, burns, and harmful dust inhalation. These tool-related hazards compound the complex safety landscape at this facility. Organizational hazards include weak safety policies, limited training, and insufficient safety governance. As shown in Table 1, the identified hazard and risk levels are summarized.

Table 1. Summary of Identified Hazards and Risk Levels

Hazard Category	Key Hazard	Risk Level
Environmental	Noise, air pollution	High
Human	Working posture, fatigue	High
Tools	Conveyor, shredder	High
Organizational	Training, safety culture	High

The environmental dimension proved particularly troubling. There were noise exposure, air pollution, and exposure to dangerous materials are among the highest environmental risks. Human hazards, such as ergonomic strain and unsafe behavior, also show high-risk levels. Similarly, tool-related hazards due to inadequate machine guarding and a lack of lockout/tagout procedures are classified as high risk. Organizational factors, including weak safety culture and lack of structured training, further amplify overall risk levels. Based on these findings, a Lean Safety-HIRARC model integrated with the 5S framework was developed to address identified hazards through a structured hierarchy of controls and a continuous improvement approach. Figure 1 illustrates the integration of Lean Safety-HIRARC. The Lean Safety for Organizational Hazard is shown in Table 2. Using the same framework, risk control measures were implemented for all identified hazards.

Table 2. Lean Safety For Organizational Hazard Risk Control

Hierarchy of Controls	The Proposed Controls	Sort (Seiri) – Eliminate Unnecessary Items	Set in Order (Seiton) – Organize for Safety	Shine (Seiso) – Clean & Inspect	Standardize (Seiketsu) – Create Consistency	Sustain (Shitsuke) – Build Culture
Elimination / Substitution	Remove outdated, conflicting, or redundant policies that confuse implementation; eliminate unsafe work incentives that prioritize output over safety. Substitute reactive supervision with proactive leadership engagement.	Eliminate obsolete documents and unnecessary administrative layers that hinder safety reporting.	Define clear lines of responsibility between management and operators.	Conduct management walkthroughs to identify and remove bureaucratic barriers to safety.	Consolidate updated safety policies, ensuring accessibility and clarity.	Embed leadership accountability and reward transparency in safety decision-making.
Engineering Controls	Design an integrated digital safety dashboard for real-time reporting of hazards, maintenance needs, and incident data.	Eliminate fragmented data storage and use centralized reporting tools.	Organize digital records and visual boards to display key safety metrics.	Verify that all visual controls (charts, dashboards) are accurate and up to date.	Develop a standardized data collection and reporting procedure.	Sustain the use of visual management tools through regular review meetings.
Administrative Controls	Establish structured safety committees and clear communication channels between supervisors, workers, and management. Formalize induction and refresher training as part of the work routine.	Sort outdated SOPs and remove unclear or unused procedures.	Arrange documentation logically for easy access during inspections and audits.	Audit compliance regularly and document corrective actions.	Develop standard templates for SOPs, briefings, and incident reports.	Foster continuous learning and peer-to-peer knowledge sharing.

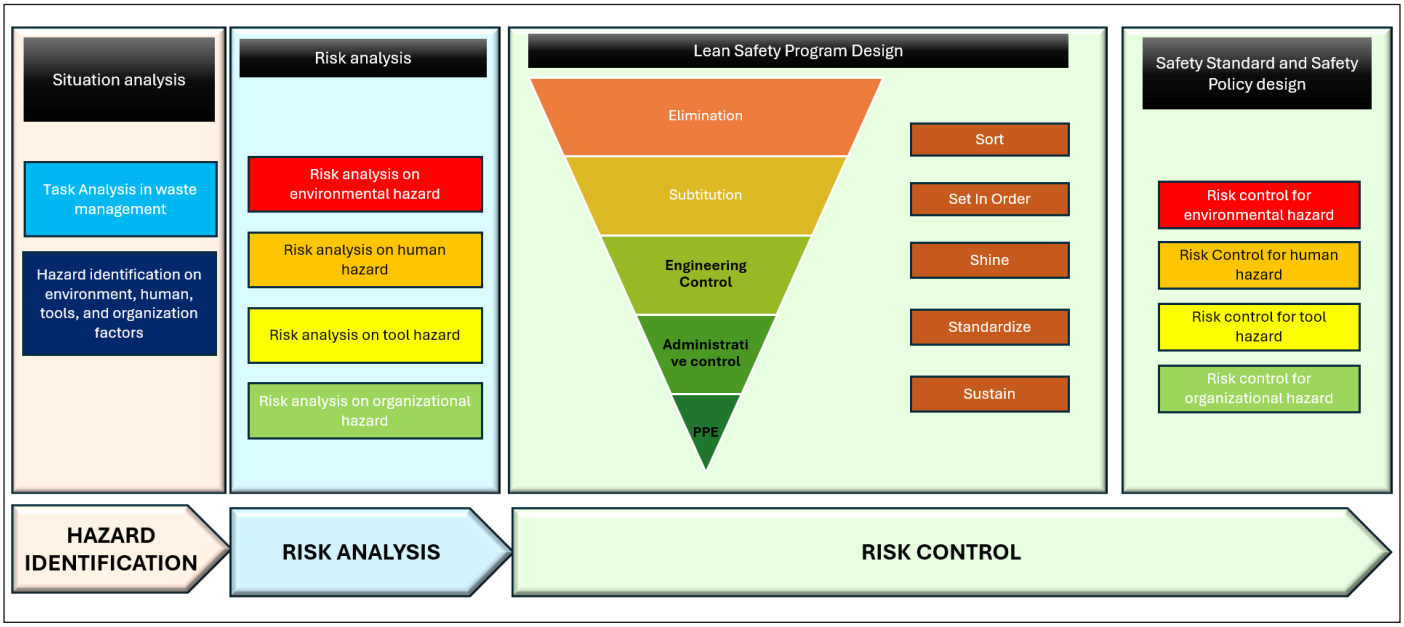


Figure 1. Integration of Lean Safety-HIRARC

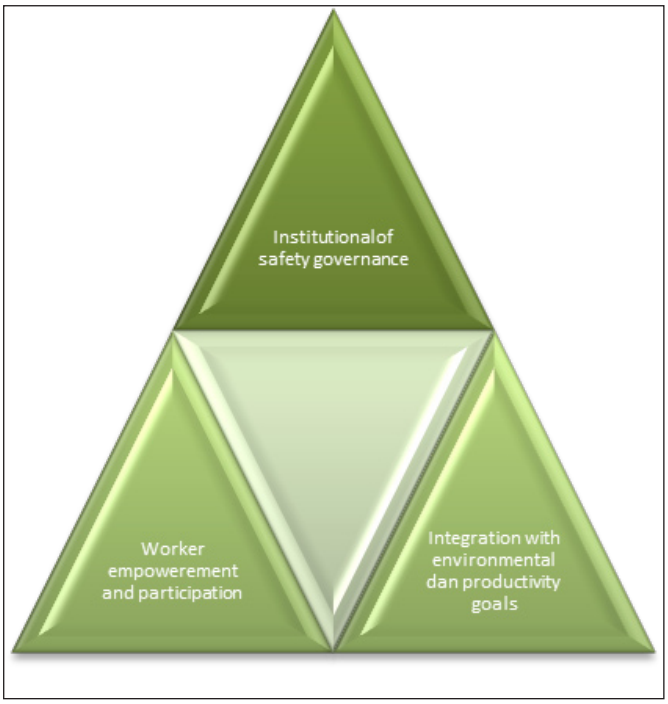


Figure 2. Three Proposed Strategic Implications

The integration of the Lean Safety-HIRARC model provides a strategic approach to enhancing safety culture through both structural and behavioral transformation. Lean principles fundamentally rest on three pillars: empowering workers to contribute meaningfully, pursuing continuous improvement as an ongoing responsibility, and systematically rooting both unsafe practice and operational inadequacies. Organization leverages the HIRARC framework that enables them to evaluate methodically and determine which risks warrant the most urgent attention. 5S approach made the HIRARC more powerful because the cultivate an organizational culture characterized by discipline, personal accountability for safety outcomes. The shine refers to the regular inspection and maintenance phase, works alongside standardized procedures to establish operational reliability. Equally importance is sustaining phase. It transforms safety from something employees view as temporary compliance requirement into a lasting habit.

Three strategic implications emerge from this integrated framework, the first concerns institutionalizing safety governance throughout the organization. Waste management activities should formalize the safety as main organizational value, establish transparent policies, and show leadership commitment in safety. The management should allocate sufficient resources to build a safety initiative. The second implication focusses on empowering workers and ensuring their active participation. All safety intervention would be better when employees identify hazards by themselves, and monitor each other's practices rather than when safety is enforced from above. Finally, organization should integrate all their safety efforts with broader environmental and productivity goals. When safety initiatives align with the lean thinking and circular economy principles, waste would be decrease, energy consumption drops, operational cost fall, and worker health and morale both improve simultaneously. The lean-safety HIRARC model emphasizes three strategic implications, as shown in Figure 2.

DISCUSSION

When we talk about human hazard in waste management, we are referring to the dangers that emerge from how worker's body's function and performs

and their mental condition. These factors can contribute meaningfully to workplace injuries, illness, and diminished productivity. The data collected from the investigation, which appears in Table 1 reveals occupational hazards as a systemic problem. They are multidimensional in nature and become deeply entangled with both operational efficiency and broader sustainability concerns. This interconnection became evident during the research.

Through careful observation, conversation with stakeholders and detailed posture analysis, there were human hazard. The most substantial hazards are the use of uncommon working poses. During waste sorting and feeding into machinery. Workers repeatedly perform monotonous bending, twisting, squatting, or overreaching. Persisted maintenance of specific postures can significantly increase the risk of musculoskeletal disorders (MSDs). The problems were particularly in the lower back, shoulders, and knees (14).

A second significant concerns emerge from the physical limitation many workers bring to their roles. Many are encountered in physically challenging tasks without adequate strength or energy, making them more exposed to exhaustion, musculoskeletal injuries, and prolonged recovery period following intensive from physical effort. The absence of routine health screenings compounds this vulnerability. The cumulative weight of this factor creates a concerning occupational health profile that deserved serious intervention (15). When fatigue and inattention combine, the consequences prove significant. Working concentration suffers, mistakes multiply, and workplace incidents become increasingly likely. Beyond these immediate threats, cognitive fatigue undermines workers motivation to adhere to the safety protocols. A fragmented safety culture within the organization further limits peer-to-peer reinforcement of safe behavior (16).

Finally, the role of motivation in safety outcomes often goes underappreciated, yet is shapes worker behavior in insightful ways. When compensation falls short and job security feels uncertain, employees naturally lose enthusiasm for following safety protocols or engaging meaningfully in safety performances. Focusing these human hazards requires a sequence of ergonomics involvements, targeted health and fitness programs, continuous safety education, and organizational transformations that promote a strong safety culture. Integrating these procedures into the broader lean safety HIRARC framework can systematically reduce human-related risks, improve worker well-being, and support contribution to sustainable waste management operations associated with SDG 3 (Good Health and Well-being) and SDG 8 (Decent Work and Economic Growth).

Waste management operation depends on specialized machinery that reliance introduces many safety concerns. The problems are varied, ranging from conveyor systems to specialized processing equipment. Each machinery was carrying distinctive risks that deserve careful attention. First, consider the conveyor belts, which are widely used for transferring and sorting waste materials. Workers a lot control close to moving parts, initiating risks of hand entrapment, pinching, or accidental contact with rotating components. The absence of adequate machine guards such as the emergency stop mechanism can cause an accident. Shredding machine has razor-sharp rotating blades that present a danger especially when worker had to maintenance task or handle materials. The shredding process generates dust that infiltrates the respiratory system. The hazard extends with the extruder machine. These hot extruders reaching temperatures between 200- and 300-degree Celsius. Pyrolysis gasification operation introduces some serious risk: potential burns, fire or explosions when the safety procedures slip. The manual and hydraulic press machines employed in manufacturing paving blocks creates a genuine crush and pinch hazards during the process of handling molds.

Designing effective workplace safety requires a comprehensive framework. Instead, organization must embrace an integrated system approach where engineering design, ergonomics optimization, behavioral reinforcement and cultural transformation work in concert (17). The simultaneous operation across multiple domains proves far more effective than isolated intervention. Issue of ergonomic strain and fatigue reveals a critical gap in how we design work environments. We need to infuse human-centered design principles to all the process layout and individual workstations to ensure the greater productivity never sacrifices the physical and mental health of people doing the work (18–19). When it comes to machinery and equipment, the strategy shifts to prioritizing engineering controls and preventive maintenance. These technical safeguards work best when combined with administrates control and measures, including standardized operating procedures and ongoing training programs that keep workers informed and engaged in safety practices.

The challenges facing waste management safety extend well beyond the physical hazards workers encounter daily. These problems reflect deeper organizational failures because of inadequate training programs, insufficient resources, and a leadership void when it comes to safety participation (20). Research steadily shows that risks decrease from governance gaps and using the safety knowledge continuity within institution, particularly shaping how safety protocols

function eventually. This organizational limitations show among managerial and operational layers. A well-engineered technical safeguard cannot perform effectively without commitment from organization to set safety into the culture. When leadership fail to defend safety as a core value, the most complicated controls tend to failure.

Worker motivation plays a crucial role. Low compensation, job insecurity, and the absence of any real acknowledgement when workers do comply with safety create worse condition and unsafe practices become normalized. Meaningful transformation requires weaving together multiple elements. A facility must connect its control hierarchy with the lean safety-5S continuous improvement cycle into one coherent system. The integration is transforming safety from a reactive function into an embedded organizational value. When employees participate identifying hazards and maintain orderly workplaces, when behavior-based safety principles guide decisions, safety shift from compliance into genuine organizational ambience.

The incorporation of the Lean Safety-HIRARC model provides a considered methodology to enhancing safety culture through both structural and behavioral transformation. Lean principles emphasize getting workers actively involved in their roles, pushing for constant refinement of process, and rooting it dangerous behaviors and operational waste. The HIRARC framework complements the evaluation process nicely. When we weave the safety recommendation into the 5S cycle, the workplace culture will value disciplines, people can be more responsible, and the reliability for safety outcomes would be delivered respectively.

Three interconnected strategies deserve highly consideration. First, safety needs to become institutionalized within governance structure in organization. Waste management entities have to improve the policies and leadership commitment, as well as adequate resource allocation. The organization must elevate safety from a checkbox exercise to a culture. The second strategy hinges on recognizing worker as safety's greater assets. When employees contribute completely in identifying hazards, setting standards, and monitoring one another's practices, safety interventions prove substantially more effective than top-down obligations alone because the workers understand operational realities that distant manager or supervisors often miss. Finally, safety initiatives dain remarkable power when integrated with environmental and productivity objectives. By aligning safety programs, with lean and circular economy principles, organizations achieve something genuinely collaborative. This study contributes to the convergence of lean organization, human factors, and safety science by proposing a mix model that improves the analysis on sustainable safety. While traditional HIRARC only focus on technical hazard control, this integration introduces constant improvement, human-centered analysis, and managerial understanding as vital components of safety. It reinforces the emerging view point in safety research that sustainable safety requires system reliability and cultural adaptation.

Engineering and administrative controls point up the committing safety across process and work design, maintenance procedures, documentation, and exposure regulation. The organization must ensure to support engineering interventions. The final hierarchy acts not only as a line of protection but also as a behavioral fortification instrument. The behavioral reinforcement needs to maintain among supervision, peer monitoring, and culture-building performances. Comparing previous studies that focus exclusively on technical hazard control, this study combines behavioral and organizational factor within a sustainability context. The structured alignment of the hierarchy of controls and the 5S principles thus advances the transition from compliance-based safety management toward a lean, participatory, and sustainability-oriented safety system. Integrating the 5S Cycle within the hierarchy of control ensures that tool related risks are managed through engineering, behavioral, and cultural strengthening. The sorting and setting-in-order stage reduces physical clutter and streamlines the workflow, directly supporting hazard elimination and engineering controls. The shine stage embeds inspection routines that detect early signs of malfunction. Through the inspection, cleanliness will make preventive maintenance more clearly. Standardized procedures guarantee operational consistency. Lastly, sustain, emphasize responsibility, and push in safety behavior into the organizational culture.

The integration transforms reactive maintenance into proactive risk management. It is ensuring that occupational safety, productivity, and sustainability grow in tandem. Organizational hazards represent systematic weaknesses that influence every aspect of work-related safety performance, from leadership commitment and policy enforcement to communication, training, and resource division. The findings of this study emphasize that occupational safety in waste management systems is influenced by an interaction of human, engineering, and organizational factors, as shown in Figure 2. The overwhelming presence of high-risk hazards across environmental, human, tool-related, and organizational domains underscores the intricate and systemic nature of safety challenges in the waste management sector.

This observation supports previous research showing that workers in waste management roles, particularly in developing countries, face a wide array of hazards. These include poorly designed ergonomic practices, exposure to harmful environmental conditions, psychosocial stressors in the work environment, and inadequate safety infrastructure.

This study has some weaknesses. First, it uses a single-case model, which may constraint the generalizability of the outcomes to other waste management perspectives. Additionally, there is a lack of long-term exposure observing and health consequence data, which avoids us from concluding a clear causal relationship between the identified environmental stressors and specific work-related health effects.

CONCLUSION

There are three key contributions to enhance the environmental and occupational health in waste management. Integrated system of hazard and risk management is the initial part. Handling multiple hazards exposed to worker need a mixed and systematic solution. Waste management plays critical responsibility to manage the worker health and safety as well as the environmental health. The following contribution is the integrative Lean Safety–HIRARC model that operationalizes the hierarchy of controls in a constant improvement framework. The framework aligns risk control, worker welfare, and operational productivity in a circular-economy-oriented systems. Conclusively, the findings highlight the significant role of organizational and behavioral factors in influential risk that indicates that technical controls alone are insufficient without supportive safety governance, worker participation, and cultural reinforcement.

Waste facilities should be acknowledged as high-risk surroundings requiring systematic exposure monitoring, standardized safety governance, and investment in engineering controls and workforce development. Integrating occupational health indicators into regulations and sustainability metrics is essential. Future research should utilize a longitudinal work design, quantitative validation, and digital technologies to enhance adaptive risk management and supportive evidence-based environmental health policy.

ACKNOWLEDGMENTS

There are no conflicts of interest. Universitas Trisakti, through the Center for Excellence in Ergonomics, Occupational Health and Safety, provided funding for this research.

AUTHORS' CONTRIBUTION

DMS: Conceptualization; Formal analysis; Methodology; Roles/Writing- original draft; and Writing-review & editing. ANH: Formal analysis, Data collecting. NA: Supervision. WS: Methodology, Data curation. TM: Supervision.

REFERENCES

1. Caetano JA, Turini LR, Oliveira CM, Rodrigues EHSBT, Freitas NM, Pamplona ACB, et al. Impact of Commuting Time on Occupational Health in the Rio de Janeiro Metropolitan Area. *J Transp Health*. 2026;49(102307):1–16. https://doi.org/10.1016/j.jth.2026.102307
2. Kumar G, Vyas S, Sharma SN, Dehalwar K. Challenges of Environmental Health in Waste Management for Peri-urban Areas. *Solid Waste Management*. 2024;149–168. https://doi.org/10.1007/978-3-031-60684-7_9
3. Katpatal A, Tandulkar D, Kularkar A, Mandpe A, Paliya S. Accumulation, Processing, and Destruction of Waste: Environmental Toxicities, Levels, and Assessment Method. *Advances in Energy from Waste*. 2024;81–113. https://doi.org/10.1016/B978-0-443-13847-8.00003-8
4. Wirtu YD, Tucho GT. E-waste: Growing Environmental and Health Problems and Its Management Alternatives in Developing Countries. *Environmental Reviews*. 2022;30(4):524–536. https://doi.org/10.1139/er-2021-0120
5. Kumar SB, Pachiyappan JK, Chandrasekar S, Karri VVSR, Krishnamurthy PT, Natarajan J, et al. Microplastics and Health Hazards: Gastrointestinal Risk Assessment Across a Multi-Species Perspective. *Asian Journal of Atmospheric Environment*. 2025;19(17):1–17. https://doi.org/10.1007/s44273-025-00068-x
6. Othman NMI, Shamsuddin AS, Sari NA, Sapak Z, Mustaffha S, Ismail SNS, et al. Types and Factors of Waste Accumulation. *Advances in Energy from Waste*. 2024;43–80. https://doi.org/10.1016/B978-0-443-13847-8.00002-6
7. Guan Z, Samarasinghe DAS, Yiu TW, Reddy R, Laird I. Examining the Risk Factors Influencing Safety Outcomes for Chinese Migrant Construction Workers in New Zealand. *Engineering, Construction and Architectural Management*. 2026;33(15):182–202. https://doi.org/10.1108/ECAM-04-2024-0451
8. Pratama GB, Caponecchia C. Examining the Influence of National Culture on Aviation Safety: A Systematic Review. *J Safety Res*. 2025;92:317–330. https://doi.org/10.1016/j.jsr.2024.11.020
9. Rodrigues T, Sá JC, Oliveira AR, Hines P, Ulewicz R, Bonamigo A. Using the Lean-Based Safety Leadership Framework to Improve Operational Efficiency and Reduce Occupational Risk: Evidence from a Case Study. *System Safety: Human - Technical Facility - E nvironment*. 2025;7(1):108–117. https://doi.org/10.2478/czoto-2025-0011
10. Kumar R, Kumar A, Kumar R. Integrating Lean and Green Strategies and Their Effect on Manufacturing Industry Performance: An Empirical Study.

Evergreen. 2025;12(4):1929–1945. https://doi.org/10.5109/7402626

11. Siang WLW, Baharudin MR, Rahman AA, Hasan NH. Are the Guidelines for HIRARC 2008 Effective for Managing Workplace Hazard? *Multidisciplinary Science Journal*. 2025;8(5):1–10. https://doi.org/10.31893/multiscience.2026345
12. Chen CK. Lean Strategy Implementation in SME Manufacturing in Developing Countries: A Systematic Literature Review. *International Journal of Lean Six Sigma*. 2026;1–24. https://doi.org/10.1108/IJLSS-06-2025-0161
13. Sá JC, Oliveira A, Hines P, Mourão F, McDermott O, Marques PA, et al. The Effects of Lean and People's Behaviours on Occupational Safety. *Production Engineering Archives*. 2025;31(1):1–14. https://doi.org/10.30657/pea.2025.31.1
14. Adiyanto O, Mohamad E, Jaafar R, Faishal M. Identification of Musculoskeletal Disorder among Eco-Brick Workers in Indonesia. *Int J Occup Saf Health*. 2023;13(1):29–40. https://doi.org/10.3126/ijosh.v13i1.44575
15. Kageyama I, Hashiguchi N, Cao J, Niwa M, Lim Y, Tsutsumi M, et al. Determination of Waste Management Workers' Physical and Psychological Load: A Cross-Sectional Study Using Biometric Data. *Int J Environ Res Public Health*. 2022;19(23):1–23. https://doi.org/10.3390/ijerph192315964
16. Schwatka NV, Jaramillo D, Dally M, Krisher L, Dexter L, Butler-Dawson J, et al. Latin American Agricultural Workers' Job Demands and Resources and the Association with Health Behaviors at Work and Overall Health. *Front Public Health*. 2022;10(838417):1–11. https://doi.org/10.3389/fpubh.2022.838417
17. Jansen T, von-den-Benken M, Lunansky G, van-Moll E, Lammers M. Risk Perception, Barriers and Working Safely at Height in Construction: A Psychological Network Approach. *BMC Public Health*. 2025;26(29):1–13. https://doi.org/10.1186/s12889-025-25548-1
18. Evans TM, Bira L, Gastelum JB, Weiss LT, Vanderford NL. Evidence for a Mental Health Crisis in Graduate Education. *Nat Biotechnol.* 2018;36:282–284. https://doi.org/10.1038/nbt.4089
19. Vornholt P, De-Choudhury M. Understanding the Role of Social Media–Based Mental Health Support among College Students: Survey and Semistructured Interviews. *JMIR Ment Health*. 2021;8(7):1–15. https://doi.org/10.2196/24512
20. Zhang J, Mao X, Feng K, Zhang Q, Liu L, Gui X. A System-Level Semantic Reliability Framework for Diagnosing Governance Failures in High-Risk Socio-Technical Systems. *Reliab Eng Syst Saf*. 2026;274(112399):1–22. https://doi.org/10.1016/j.ress.2026.112399

TURNITIN

by Dian Mardi Safitri

Submission date: 19-Jun-2026 07:03AM (UTC+0700)
Submission ID: 2985779913
File name: 15._88699_Safitri_hal_129-137.pdf (1.2M)
Word count: 5576
Character count: 35050

Jurnal Kesehatan Lingkungan
Journal of Environmental Health
Journal Home Page: https://e-journal.unair.ac.id/JKL
Special Issue | Vol. 18 No. 1si
DOI: 10.20473/jkl.v18i1si.2026.129-137
ISSN: 1829 - 7285 | E-ISSN: 2040 - 881X
ORIGINAL RESEARCH Open Access

SUSTAINABLE OCCUPATIONAL SAFETY AND HEALTH FOR THE ENVIRONMENT AND EDUCATION-BASED WASTE MANAGEMENT CENTER IN BANYUMAS, INDONESIA

Dian Mardi Safitri[1,2*], Anik Nur Habyba[1,5], Winnie Septiani[1,2], Nora Azmi[1,2], Bambang Tri Wardoyo[2,3], Toru Matsumoto[4]

[1]Industrial Engineering Department, Faculty of Industrial Technology, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[2]Center of Excellence for Ergonomics, Occupational Health, and Safety, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[3]Visual Communication Design Department, Faculty of Art and Design, Universitas Trisakti, Jakarta 11440, Special Capital Region of Jakarta, Indonesia
[4]Institute of Environmental Science and Technology, The University of Kitakyushu, Fukuoka 808-0135, Japan
[5]Department of Industrial Engineering and Management, Yuan Ze University, Taoyuan City 32003, Taiwan

Corresponding Author:
*) dianm@trisakti.ac.id

Article Info

Submitted	: 3 March 2026
In reviewed	: 29 April 2026
Accepted	: 19 May 2026
Available Online	: 30 June 2026

Keywords : *Hazard Identification Risk Assessment and Risk Control, Lean Safety, Safety Culture, Sustainable Occupational Safety and Health, Waste Management*

Published by *Faculty of Public Health Universitas Airlangga*

Abstract

Introduction: *Worker in integrated waste processing facilities are exposed to a range of environmental health stressor from machinery processing, human, and organizational processes. This study aims to develop a sustainable occupational safety and health (OSH) model for an environment-and education-based waste management center (TPA-BLE) in Banyumas, Indonesia.* ***Methods:*** *A mixed-method approach was used combining field observation, environmental measurements, qualitative risk assessment, and stakeholder consultation. The Hazard Identification, Risk Assessment, and Risk Control (HIRARC) framework was used to systematically identify hazards and assess the risks in environmental, human, equipment, and organizational aspects. The risk control strategies were integrating Lean Safety principles and the 5S Cycle to reinforce sustainability and continuous improvement.* ***Results and Discussion:*** *Finding shows worker are exposed to high-risk health stressor such as noise, airborne particulates, heat, ergonomic strain, and hazardous emission, compounded by the organizational and behavioral factors. The Lean-Safety HIRARC model combines the hierarchy of controls with continuous improvement to improve worker protection and operational sustainability. The integrated approach reframes waste management center as an essential environmental health site that free from the OSH issue.* ***Conclusion:*** *The study proposes a new Lean Safety-HIRARC model as a continuous improvement framework. The findings highlight a practical, policy-relevant framework for strengthening environmental and occupational health performance in waste management systems in developing countries.*

INTRODUCTION

The quality of life for workers serves as a key indicator for realizing SDG 3, which focuses on health and well-being SDG 8, which emphasizes decent work and economic growth; and SDG 11 (1). Workers in waste management face four primary hazards: environmental, human, operational, and organizational factors. The challenges of waste management, exacerbated by population growth, represent a significant issue for urban areas today. Effective waste management has profound implications for individuals' lives, the environment, the economy, and public health. Waste management poses significant challenges to worker health and environmental integrity (2). Disposing waste materials by burying them

Cite this as :
Safitri DM, Habyba AN, Septiani W, Azmi N, Wardoyo BT, Matsumoto T. Sustainable Occupational Safety and Health for the Environment and Education-Based Waste Management Center in Banyumas, Indonesia. *Jurnal Kesehatan Lingkungan*. 2026;18(1si):129-137. https://doi.org/10.20473/jkl.v18i1si.2026.129-137

into designated areas of land, collecting waste in open area, sorting and processing hazards to the employees and harm the environment due to the contamination (3). The health risks must be understood to build a strategy that is safer and more effective (4). There are some potential hazards to the worker healthiness especially from inhalation or skin exposure from pollutants (5). The prior observation at one of the Waste Bank in Depok, West Java and in Banyumas was carried out to find all the evidence of hazards and strengthen the findings from literature review.

In Central Java, especially in Banyumas, there is a Waste Management Center built as an environmental and education-based waste management facility. It is mentioned as TPA-BLE Waste Management Center. It serves as a modern and integrated waste management, supporting the circular economy. The TPA-BLE has been built to manage and reduce the waste comes from community in Banyumas residence. TPA-BLE has a land area of 3.5 hectares and has a processing capacity of up to 75 tons/day to minimize the landfilling activities, promoting the awareness of transforming the waste into value, educate people to sort household garbage before it was sent to the temporary waste drop center. The educational role of the waste bank plays a significant contribution to make the community literate about the waste management and how to support sustainability.

These issues highlight the urgency of strengthening occupational health and safety governance and cultivating a robust safety system. Environmental factors include inadequate lighting, high-intensity noise exposure reaching 90dB for 6-8 hours per day, smoke pollution from burning, and exposure to hazardous materials from community waste in a mixed state (6). Human factors include unnatural working postures, workers' health and fitness, mental burden, and psychological and behavioral aspects such as safety participation, knowledge, behavior, motivation, and awareness (7). Work tool factors include the use of machines and hand tools in waste processing and management, while organizational factors include safety climate, safety policy, and safety culture (8). The second section presents the consequences of occupational diseases, work-related diseases, and work accidents. The last section highlights long-term impacts, such as improving quality of life, environmental sustainability, and contributing to decent work and economic growth (SDG 8).

OHS problems in waste management operations require intervention in environmental, human, work equipment, and organizational factors. The Lean safety approach serves as the basis for this research to address OHS problems in waste management (9). Lean Safety is a lean-thinking management approach focusing on safety. This approach is suitable for improving safety because it requires a proactive stance and greater human involvement to foster a safety culture and climate. The four hazard factors in the preliminary study human, organizational, work equipment, and environmental require holistic safety management. The Lean safety framework will manage the hazard identification, risk analysis, and risk control (HIRARC) process sustainably through the Sort (sorting), Set in Order (arranging), Shine (cleaning), Standardize (standardizing the process), and Sustain (maintaining) cycle (10).

The problem-solving approach is divided into three main parts: Hazard Identification, Risk Analysis, and Risk Control (11). The first stage, Hazard Identification, includes two main steps: "Situation Analysis and Problem Identification" and "Task Analysis of Waste Management." This step involves identifying hazards from the environment, work equipment, people, and organizations. The second stage, Risk Analysis, includes analyzing the risk levels for various hazards: environmental, human, work equipment, and organizational. Each type of hazard is examined to determine its consequences and impacts. The third stage, Risk Control, includes two sub-sections: Lean Safety Program Design and Safety Standard, Safety Policy Design.

The first sub-section describes the risk control hierarchy, starting with hazard elimination, hazard substitution, isolation (limiting human access to the source of danger), engineering controls (work system design), and the use of personal protective equipment (PPE). The second sub-section covers the 5S (Sort, Set in Order, Shine, Standardize, Sustain) steps and control standards for various hazards (environment, people, work tools, and organization) (12). This is a comprehensive approach to sustainable occupational safety risk control that ensures a safe and healthy work environment (13). A systematic and structured approach to identifying, analyzing, and controlling risks, which is used as a basis for improving occupational safety. This research is novel in its application of Lean Safety and HIRARC concepts to improve sustainable occupational safety and health. Comparisons with the literature are used to demonstrate the position and novelty of this research.

METHODS

This study adopts a mixed-method approach integrating qualitative field observation, quantitative risk assessment, and participatory evaluation to develop a sustainable occupational safety and health model for waste management systems. The unit analysis is the

integrated waste management system, specifically at the Environment and Education-based Waste Management Center in Banyumas Regency, Central Java, Indonesia. The study involves differs respondent as principal data source. Eight respondents were invited, including supervisor, and the workers of sorting, burning, and paving block production.

The research methodology integrates the HIRARC (Hazar Identification, Risk Assessment and Risk Control) framework, with the Kaizen lean principles that consist of 5S Cycle (Sort, Set in Order, Shine, Standardize and Sustain). The HIRARC was implemented as a framework for Occupational Health and Safety mitigation, while the Lean concept support and ensure the health and safety culture that comes from HIRARC process.

This study utilized a variety of informants and data sources to gather qualitative and quantitative information. The interview participants are 8, including the supervisor and waste workers. The methodological foundation combines the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) framework with the lean philosophy and the 5S Cycle (Sort, Set in Order, Shine, Standardize, Sustain) to embed risk management within continuous improvement practices. The choice of TPA-BLE Banyumas as the study site is grounded in its strategic importance as a regional model for integrated waste management, showcasing both technical innovation and the persistent challenge of ensuring sustainable and safe operations.

The initial phase of HIRARC is hazard identification. The hazards identified include human hazard, environment, work tools and organization. Literature review and field observation were done to identify all of these hazards. Furthermore, the consequences and impacts of each source of danger are identified on the sustainability pillars (environment, economy, and social). This is done by collecting data on undesirable events as evidence. The next stage is risk analysis and assessment. This assessment includes the severity of the impact and the likelihood or probability of its occurrence. Based on the risk analysis results, the priority of risk control efforts is determined using the hierarchy of controls, which includes elimination, substitution, isolation, engineering controls, and personal protective equipment (PPE). Then, a lean safety program is designed using the 5S strategy (Sort, Set in Order, Shine, Standardize, Sustain) to create a safer, more efficient work environment.

The design of Safety Standards and Safety Policies is also carried out to establish the required safety standards. In hazard identification, potential hazards were categorized into four domains: environmental, human, tool (equipment), and organizational factors. Then, in the risk assessment, each identified hazard was evaluated based on its likelihood, frequency, and severity of consequences. Finally, in the risk control, hazards were prioritized for control planning, and the evaluation process included worker participation to ensure contextual understanding of operational hazards.

The approach of lean safety plays a critical role by serving a bridge between strategy recommendation and the safety culture cycle development. The lean safety ensures the improvements are aligned with operational efficiency, hazard elimination, and worker participation. The lean safety approach was integrated to align safety improvement with operational efficiency, emphasizing hazard elimination, error-proofing, and worker empowerment. The 5S was used as the operational mechanism to embed safety culture and discipline in daily practices: Sort: Identify and remove non-value adding items, creating hazards; Set in Order: Organize tools and materials ergonomically for safety and efficiency; Shine: Maintain cleanliness to prevent contamination and early detect unsafe conditions; Standardized: Develop clear and consistent work standards and inspection routines; and Sustain: Reinforce safety culture through habit formation, discipline, and continuous learning. Each dimension was systematically mapped to the hierarchy of controls (elimination, substitution, engineering, administrative, and PPE), resulting in a structured, measurable improvement matrix.

The results were synthesized into the Lean Safety-HIRARC Model, which integrates the risk hierarchy, 5S discipline, and continuous improvement. The model was validated through expert review (practitioners and academics) to ensure relevance, feasibility, and sustainability. This study identifies the core sustainability parameters used to identify the consequences and impact of various hazards as environmental parameters that focus on ecological integrity and the mitigation of risk like air pollution and hazardous substance exposure, economic parameters relating to operational efficiency, productivity, and the advancement of the circular economy, and social parameters emphasizing worker health, safety, and well-being.

RESULTS

As assessment of workplace hazard was concerning on some occupational risk, spanning multiple categories. The worker their faces environmental danger, human factor problems, equipment-related threats, and organizational shortcomings. The majorities of these hazards classified as high risk. Human-related factors constitute another significant concern, especially

in worker behavior and physiology. Awkward posture dominates their working movement. Most notably, personal protective equipment (PPE) adoption remains inconsistent across the facilities. Conveyor belts, shredders and extrudes present entrapment risk along the possibilities of laceration, burns, and harmful dust inhalation. These tool-related hazards compound the complex safety landscape at this facility. Organizational hazards include weak safety policies, limited training, and insufficient safety governance. As shown in Table 1, the identified hazard and risk levels are summarized.

Table 1. Summary of Identified Hazards and Risk Levels

Hazard Category	Key Hazard	Risk Level
Environmental	Noise, air pollution	High
Human	Working posture, fatigue	High
Tools	Conveyor, shredder	High
Organizational	Training, safety culture	High

The environmental dimension proved particularly troubling. There were noise exposure, air pollution, and exposure to dangerous materials are among the highest environmental risks. Human hazards, such as ergonomic strain and unsafe behavior, also show high-risk levels. Similarly, tool-related hazards due to inadequate machine guarding and a lack of lockout/tagout procedures are classified as high risk. Organizational factors, including weak safety culture and lack of structured training, further amplify overall risk levels. Based on these findings, a Lean Safety-HIRARC model integrated with the 5S framework was developed to address identified hazards through a structured hierarchy of controls and a continuous improvement approach. Figure 1 illustrates the integration of Lean Safety-HIRARC. The Lean Safety for Organizational Hazard is shown in Table 2. Using the same framework, risk control measures were implemented for all identified hazards.

Table 2. Lean Safety For Organizational Hazard Risk Control

Hierarchy of Controls	The Proposed Controls	Sort (Seiri) – Eliminate Unnecessary Items	Set in Order (Seiton) – Organize for Safety	Shine (Seiso) – Clean & Inspect	Standardize (Seiketsu) – Create Consistency	Sustain (Shitsuke) – Build Culture
Elimination / Substitution	Remove outdated, conflicting, or redundant policies that confuse implementation; eliminate unsafe work incentives that prioritize output over safety. Substitute reactive supervision with proactive leadership engagement.	Eliminate obsolete documents and unnecessary administrative layers that hinder safety reporting.	Define clear lines of responsibility between management and operators.	Conduct management walkthroughs to identify and remove bureaucratic barriers to safety.	Consolidate updated safety policies, ensuring accessibility and clarity.	Embed leadership accountability and reward transparency in safety decision-making.
Engineering Controls	Design an integrated digital safety dashboard for real-time reporting of hazards, maintenance needs, and incident data.	Eliminate fragmented data storage and use centralized reporting tools.	Organize digital records and visual boards to display key safety metrics.	Verify that all visual controls (charts, dashboards) are accurate and up to date.	Develop a standardized data collection and reporting procedure.	Sustain the use of visual management tools through regular review meetings.
Administrative Controls	Establish structured safety committees and clear communication channels between supervisors, workers, and management. Formalize induction and refresher training as part of the work routine.	Sort outdated SOPs and remove unclear or unused procedures.	Arrange documentation logically for easy access during inspections and audits.	Audit compliance regularly and document corrective actions.	Develop standard templates for SOPs, briefings, and incident reports.	Foster continuous learning and peer-to-peer knowledge sharing.

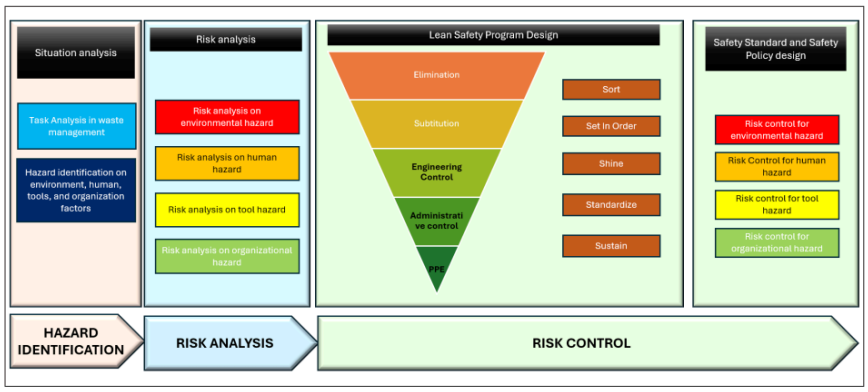


Figure 1. Integration of Lean Safety-HIRARC

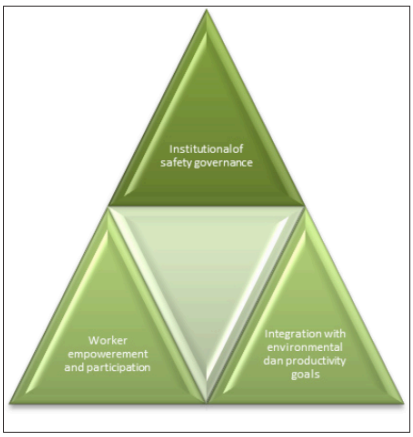


Figure 2. Three Proposed Strategic Implications

The integration of the Lean Safety-HIRARC model provides a strategic approach to enhancing safety culture through both structural and behavioral transformation. Lean principles fundamentally rest on three pillars: empowering workers to contribute meaningfully, pursuing continuous improvement as an ongoing responsibility, and systematically rooting both unsafe practice and operational inadequacies. Organization leverages the HIRARC framework that enables them to evaluate methodically and determine which risks warrant the most urgent attention. 5S approach made the HIRARC more powerful because the cultivate an organizational culture characterized by discipline, personal accountability for safety outcomes. The shine refers to the regular inspection and maintenance phase, works alongside standardized procedures to establish operational reliability. Equally importance is sustaining phase. It transforms safety from something employees view as temporary compliance requirement into a lasting habit.

Three strategic implications emerge from this integrated framework, the first concerns institutionalizing safety governance throughout the organization. Waste management activities should formalize the safety as main organizational value, establish transparent policies, and show leadership commitment in safety. The management should allocate sufficient resources to build a safety initiative. The second implication focusses on empowering workers and ensuring their active participation. All safety intervention would be better when employees identify hazards by themselves, and monitor each other's practices rather than when safety is enforced from above. Finally, organization should integrate all their safety efforts with broader environmental and productivity goals. When safety initiatives align with the lean thinking and circular economy principles, waste would be decrease, energy consumption drops, operational cost fall, and worker health and morale both improve simultaneously. The lean-safety HIRARC model emphasizes three strategic implications, as shown in Figure 2.

DISCUSSION

When we talk about human hazard in waste management, we are referring to the dangers that emerge from how worker's body's function and performs

and their mental condition. These factors can contribute meaningfully to workplace injuries, illness, and diminished productivity. The data collected from the investigation, which appears in Table 1 reveals occupational hazards as a systemic problem. They are multidimensional in nature and become deeply entangled with both operational efficiency and broader sustainability concerns. This interconnection became evident during the research.

Through careful observation, conversation with stakeholders and detailed posture analysis, there were human hazard. The most substantial hazards are the use of uncommon working poses. During waste sorting and feeding into machinery. Workers repeatedly perform monotonous bending, twisting, squatting, or overreaching. Persisted maintenance of specific postures can significantly increase the risk of musculoskeletal disorders (MSDs). The problems were particularly in the lower back, shoulders, and knees (14).

A second significant concerns emerge from the physical limitation many workers bring to their roles. Many are encountered in physically challenging tasks without adequate strength or energy, making them more exposed to exhaustion, musculoskeletal injuries, and prolonged recovery period following intensive from physical effort. The absence of routine health screenings compounds this vulnerability. The cumulative weight of this factor creates a concerning occupational health profile that deserved serious intervention (15). When fatigue and inattention combine, the consequences prove significant. Working concentration suffers, mistakes multiply, and workplace incidents become increasingly likely. Beyond these immediate threats, cognitive fatigue undermines workers motivation to adhere to the safety protocols. A fragmented safety culture within the organization further limits peer-to-peer reinforcement of safe behavior (16).

Finally, the role of motivation in safety outcomes often goes underappreciated, yet is shapes worker behavior in insightful ways. When compensation falls short and job security feels uncertain, employees naturally lose enthusiasm for following safety protocols or engaging meaningfully in safety performances. Focusing these human hazards requires a sequence of ergonomics involvements, targeted health and fitness programs, continuous safety education, and organizational transformations that promote a strong safety culture. Integrating these procedures into the broader lean safety HIRARC framework can systematically reduce human-related risks, improve worker well-being, and support contribution to sustainable waste management operations associated with SDG 3 (Good Health and Well-being) and SDG 8 (Decent Work and Economic Growth).

Waste management operation depends on specialized machinery that reliance introduces many safety concerns. The problems are varied, ranging from conveyor systems to specialized processing equipment. Each machinery was carrying distinctive risks that deserve careful attention. First, consider the conveyor belts, which are widely used for transferring and sorting waste materials. Workers a lot control close to moving parts, initiating risks of hand entrapment, pinching, or accidental contact with rotating components. The absence of adequate machine guards such as the emergency stop mechanism can cause an accident. Shredding machine has razor-sharp rotating blades that present a danger especially when worker had to maintenance task or handle materials. The shredding process generates dust that infiltrates the respiratory system. The hazard extends with the extruder machine. These hot extruders reaching temperatures between 200- and 300-degree Celsius. Pyrolysis gasification operation introduces some serious risk: potential burns, fire or explosions when the safety procedures slip. The manual and hydraulic press machines employed in manufacturing paving blocks creates a genuine crush and pinch hazards during the process of handling molds.

Designing effective workplace safety requires a comprehensive framework. Instead, organization must embrace an integrated system approach where engineering design, ergonomics optimization, behavioral reinforcement and cultural transformation work in concert (17). The simultaneous operation across multiple domains proves far more effective than isolated intervention. Issue of ergonomic strain and fatigue reveals a critical gap in how we design work environments. We need to infuse human-centered design principles to all the process layout and individual workstations to ensure the greater productivity never sacrifices the physical and mental health of people doing the work (18–19). When it comes to machinery and equipment, the strategy shifts to prioritizing engineering controls and preventive maintenance. These technical safeguards work best when combined with administrates control and measures, including standardized operating procedures and ongoing training programs that keep workers informed and engaged in safety practices.

The challenges facing waste management safety extend well beyond the physical hazards workers encounter daily. These problems reflect deeper organizational failures because of inadequate training programs, insufficient resources, and a leadership void when it comes to safety participation (20). Research steadily shows that risks decrease from governance gaps and using the safety knowledge continuity within institution, particularly shaping how safety protocols

function eventually. This organizational limitations show among managerial and operational layers. A well-engineered technical safeguard cannot perform effectively without commitment from organization to set safety into the culture. When leadership fail to defend safety as a core value, the most complicated controls tend to failure.

Worker motivation plays a crucial role. Low compensation, job insecurity, and the absence of any real acknowledgement when workers do comply with safety create worse condition and unsafe practices become normalized. Meaningful transformation requires weaving together multiple elements. A facility must connect its control hierarchy with the lean safety-5S continuous improvement cycle into one coherent system. The integration is transforming safety from a reactive function into an embedded organizational value. When employees participate identifying hazards and maintain orderly workplaces, when behavior-based safety principles guide decisions, safety shift from compliance into genuine organizational ambience.

The incorporation of the Lean Safety-HIRARC model provides a considered methodology to enhancing safety culture through both structural and behavioral transformation. Lean principles emphasize getting workers actively involved in their roles, pushing for constant refinement of process, and rooting it dangerous behaviors and operational waste. The HIRARC framework complements the evaluation process nicely. When we weave the safety recommendation into the 5S cycle, the workplace culture will value disciplines, people can be more responsible, and the reliability for safety outcomes would be delivered respectively.

Three interconnected strategies deserve highly consideration. First, safety needs to become institutionalized within governance structure in organization. Waste management entities have to improve the policies and leadership commitment, as well as adequate resource allocation. The organization must elevate safety from a checkbox exercise to a culture. The second strategy hinges on recognizing worker as safety's greater assets. When employees contribute completely in identifying hazards, setting standards, and monitoring one another's practices, safety interventions prove substantially more effective than top-down obligations alone because the workers understand operational realities that distant manager or supervisors often miss. Finally, safety initiatives dain remarkable power when integrated with environmental and productivity objectives. By aligning safety programs, with lean and circular economy principles, organizations achieve something genuinely collaborative. This study contributes to the convergence of lean organization, human factors, and safety science by proposing a mix model that improves the analysis on sustainable safety. While traditional HIRARC only focus on technical hazard control, this integration introduces constant improvement, human-centered analysis, and managerial understanding as vital components of safety. It reinforces the emerging view point in safety research that sustainable safety requires system reliability and cultural adaptation.

Engineering and administrative controls point up the committing safety across process and work design, maintenance procedures, documentation, and exposure regulation. The organization must ensure to support engineering interventions. The final hierarchy acts not only as a line of protection but also as a behavioral fortification instrument. The behavioral reinforcement needs to maintain among supervision, peer monitoring, and culture-building performances. Comparing previous studies that focus exclusively on technical hazard control, this study combines behavioral and organizational factor within a sustainability context. The structured alignment of the hierarchy of controls and the 5S principles thus advances the transition from compliance-based safety management toward a lean, participatory, and sustainability-oriented safety system. Integrating the 5S Cycle within the hierarchy of control ensures that tool related risks are managed through engineering, behavioral, and cultural strengthening. The sorting and setting-in-order stage reduces physical clutter and streamlines the workflow, directly supporting hazard elimination and engineering controls. The shine stage embeds inspection routines that detect early signs of malfunction. Through the inspection, cleanliness will make preventive maintenance more clearly. Standardized procedures guarantee operational consistency. Lastly, sustain, emphasize responsibility, and push in safety behavior into the organizational culture.

The integration transforms reactive maintenance into proactive risk management. It is ensuring that occupational safety, productivity, and sustainability grow in tandem. Organizational hazards represent systematic weaknesses that influence every aspect of work-related safety performance, from leadership commitment and policy enforcement to communication, training, and resource division. The findings of this study emphasize that occupational safety in waste management systems is influenced by an interaction of human, engineering, and organizational factors, as shown in Figure 2. The overwhelming presence of high-risk hazards across environmental, human, tool-related, and organizational domains underscores the intricate and systemic nature of safety challenges in the waste management sector.

This observation supports previous research showing that workers in waste management roles, particularly in developing countries, face a wide array of hazards. These include poorly designed ergonomic practices, exposure to harmful environmental conditions, psychosocial stressors in the work environment, and inadequate safety infrastructure.

This study has some weaknesses. First, it uses a single-case model, which may constraint the generalizability of the outcomes to other waste management perspectives. Additionally, there is a lack of long-term exposure observing and health consequence data, which avoids us from concluding a clear causal relationship between the identified environmental stressors and specific work-related health effects.

CONCLUSION

There are three key contributions to enhance the environmental and occupational health in waste management. Integrated system of hazard and risk management is the initial part. Handling multiple hazards exposed to worker need a mixed and systematic solution. Waste management plays critical responsibility to manage the worker health and safety as well as the environmental health. The following contribution is the integrative Lean Safety–HIRARC model that operationalizes the hierarchy of controls in a constant improvement framework. The framework aligns risk control, worker welfare, and operational productivity in a circular-economy-oriented systems. Conclusively, the findings highlight the significant role of organizational and behavioral factors in influential risk that indicates that technical controls alone are insufficient without supportive safety governance, worker participation, and cultural reinforcement.

Waste facilities should be acknowledged as high-risk surroundings requiring systematic exposure monitoring, standardized safety governance, and investment in engineering controls and workforce development. Integrating occupational health indicators into regulations and sustainability metrics is essential. Future research should utilize a longitudinal work design, quantitative validation, and digital technologies to enhance adaptive risk management and supportive evidence-based environmental health policy.

ACKNOWLEDGMENTS

There are no conflicts of interest. Universitas Trisakti, through the Center for Excellence in Ergonomics, Occupational Health and Safety, provided funding for this research.

AUTHORS' CONTRIBUTION

DMS: Conceptualization; Formal analysis; Methodology; Roles/Writing- original draft; and Writing-review & editing. ANH: Formal analysis, Data collecting. NA: Supervision. WS: Methodology, Data curation. TM: Supervision.

REFERENCES

1. Caetano JA, Turini LR, Oliveira CM, Rodrigues EHSBT, Freitas NM, Pamplona ACB, et al. Impact of Commuting Time on Occupational Health in the Rio de Janeiro Metropolitan Area. *J Transp Health*. 2026;49(102307):1–16. https://doi.org/10.1016/j.jth.2026.102307
2. Kumar G, Vyas S, Sharma SN, Dehalwar K. Challenges of Environmental Health in Waste Management for Peri-urban Areas. *Solid Waste Management*. 2024;149–168. https://doi.org/10.1007/978-3-031-60684-7_9
3. Katpatal A, Tandulkar D, Kularkar A, Mandpe A, Paliya S. Accumulation, Processing, and Destruction of Waste: Environmental Toxicities, Levels, and Assessment Method. *Advances in Energy from Waste*. 2024;81–113. https://doi.org/10.1016/B978-0-443-13847-8.00003-8
4. Wirtu YD, Tucho GT. E-waste: Growing Environmental and Health Problems and Its Management Alternatives in Developing Countries. *Environmental Reviews*. 2022;30(4):524–536. https://doi.org/10.1139/er-2021-0120
5. Kumar SB, Pachiyappan JK, Chandrasekar S, Karri VVSR, Krishnamurthy PT, Natarajan J, et al. Microplastics and Health Hazards: Gastrointestinal Risk Assessment Across a Multi-Species Perspective. *Asian Journal of Atmospheric Environment*. 2025;19(17):1–17. https://doi.org/10.1007/s44273-025-00068-x
6. Othman NMI, Shamsuddin AS, Sari NA, Sapak Z, Mustaffha S, Ismail SNS, et al. Types and Factors of Waste Accumulation. *Advances in Energy from Waste*. 2024;43–80. https://doi.org/10.1016/B978-0-443-13847-8.00002-6
7. Guan Z, Samarasinghe DAS, Yiu TW, Reddy R, Laird I. Examining the Risk Factors Influencing Safety Outcomes for Chinese Migrant Construction Workers in New Zealand. *Engineering, Construction and Architectural Management*. 2026;33(15):182–202. https://doi.org/10.1108/ECAM-04-2024-0451
8. Pratama GB, Caponecchia C. Examining the Influence of National Culture on Aviation Safety: A Systematic Review. *J Safety Res*. 2025;92:317–330. https://doi.org/10.1016/j.jsr.2024.11.020
9. Rodrigues T, Sá JC, Oliveira AR, Hines P, Ulewicz R, Bonamigo A. Using the Lean-Based Safety Leadership Framework to Improve Operational Efficiency and Reduce Occupational Risk: Evidence from a Case Study. *System Safety: Human - Technical Facility - E nvironment*. 2025;7(1):108–117. https://doi.org/10.2478/czoto-2025-0011
10. Kumar R, Kumar A, Kumar R. Integrating Lean and Green Strategies and Their Effect on Manufacturing Industry Performance: An Empirical Study.

Evergreen. 2025;12(4):1929–1945. https://doi.org/10.5109/7402626

11. Siang WLW, Baharudin MR, Rahman AA, Hasan NH. Are the Guidelines for HIRARC 2008 Effective for Managing Workplace Hazard? *Multidisciplinary Science Journal*. 2025;8(5):1–10. https://doi.org/10.31893/multiscience.2026345
12. Chen CK. Lean Strategy Implementation in SME Manufacturing in Developing Countries: A Systematic Literature Review. *International Journal of Lean Six Sigma*. 2026;1–24. https://doi.org/10.1108/IJLSS-06-2025-0161
13. Sá JC, Oliveira A, Hines P, Mourão F, McDermott O, Marques PA, et al. The Effects of Lean and People's Behaviours on Occupational Safety. *Production Engineering Archives*. 2025;31(1):1–14. https://doi.org/10.30657/pea.2025.31.1
14. Adiyanto O, Mohamad E, Jaafar R, Faishal M. Identification of Musculoskeletal Disorder among Eco-Brick Workers in Indonesia. *Int J Occup Saf Health*. 2023;13(1):29–40. https://doi.org/10.3126/ijosh.v13i1.44575
15. Kageyama I, Hashiguchi N, Cao J, Niwa M, Lim Y, Tsutsumi M, et al. Determination of Waste Management Workers' Physical and Psychological Load: A Cross-Sectional Study Using Biometric Data. *Int J Environ Res Public Health*. 2022;19(23):1–23. https://doi.org/10.3390/ijerph192315964
16. Schwatka NV, Jaramillo D, Dally M, Krisher L, Dexter L, Butler-Dawson J, et al. Latin American Agricultural Workers' Job Demands and Resources and the Association with Health Behaviors at Work and Overall Health. *Front Public Health*. 2022;10(838417):1–11. https://doi.org/10.3389/fpubh.2022.838417
17. Jansen T, Benken Mvd, Lunansky G, Moll Ev, Lammers M. Risk Perception, Barriers and Working Safely at Height in Construction: A Psychological Network Approach. *BMC Public Health*. 2025;26(29):1–13. https://doi.org/10.1186/s12889-025-25548-1
18. Evans TM, Bira L, Gastelum JB, Weiss LT, Vanderford NL. Evidence for a Mental Health Crisis in Graduate Education. *Nat Biotechnol*. 2018;36:282–284. https://doi.org/10.1038/nbt.4089
19. Vornholt P, Choudhury Md. Understanding the Role of Social Media–Based Mental Health Support among College Students: Survey and Semistructured Interviews. *JMIR Ment Health*. 2021;8(7):1–15. https://doi.org/10.2196/24512
20. Zhang J, Mao X, Feng K, Zhang Q, Liu L, Gui X. A System-Level Semantic Reliability Framework for Diagnosing Governance Failures in High-Risk Socio-Technical Systems. *Reliab Eng Syst Saf*. 2026;274(112399):1–22. https://doi.org/10.1016/j.ress.2026.112399

TURNITIN

ORIGINALITY REPORT

7%	7%	4%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	e-journal.unair.ac.id Internet Source	2%
2	journal.trunojoyo.ac.id Internet Source	1%
3	my.learningeverest.com Internet Source	1%
4	Submitted to Universitas Diponegoro Student Paper	<1%
5	lean5sproducts.com Internet Source	<1%
6	Abdul Hakim Zakkiy Fasya, Mursyidul Ibad, Kuuni Ulfah Naila El Muna. "Analysis of Determinant Factors of Carbon Efficiency in Indonesia Based on Domestic Waste Management using Causal Machine Learning", JURNAL KESEHATAN LINGKUNGAN, 2025 Publication	<1%
7	ideas.repec.org Internet Source	<1%
8	www.frontiersin.org Internet Source	<1%
9	jurnal.upnyk.ac.id Internet Source	<1%
10	www.degruyterbrill.com Internet Source	<1%
11	www.evidensia.eco Internet Source	

		<1%
12	bucket-ox15x1.s3.ap-southeast-1.amazonaws.com Internet Source	<1%
13	publikasi.mercubuana.ac.id Internet Source	<1%
14	inscricao.faculdadeitop.edu.br Internet Source	<1%
15	www.e3s-conferences.org Internet Source	<1%

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		