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INDUSTRIAL WASTE MANAGEMENT RESEARCH: A QUANTITATIVE BIBLIOMETRIC EXPLORATION

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Abstract. *The persistent generation and improper management of industrial waste, coupled with resource depletion and environmental degradation, pose significant challenges to achieving sustainability in human life. The burden associated with industrial waste intensifies both ecological and public health risks. Effective industrial waste management requires a thorough understanding of its sources and geographical distribution. In this study, we conducted a bibliometric analysis of English-language publications from the past decade indexed in the Dimensions database, using the keyword "industrial waste management." The analysis focused on publication trends, leading journals, academic impact metrics such as total citations, Field Citation Ratio (FCR), and Relative Citation Ratio (RCR), as well as identifying the most cited articles and their alignment with the United Nations Sustainable Development Goals (SDGs).*

INTRODUCTION

Waste is a material pertaining to the denied, declined, discarded mass and undesirable extra volume, which is created by various human caused and/or natural processes [1]. It may be classified into numerous groups based on their source of creation, harmful assets, management approaches, and degrading features. Figure 1 illustrates waste types based on different categories.

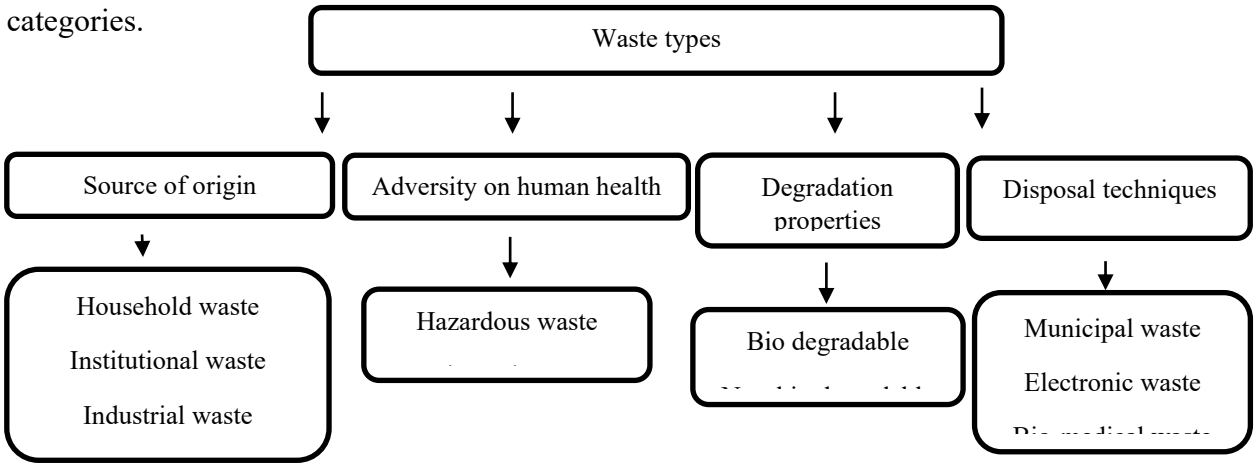

Figure 1. Types of waste by categories

Many of industries produce waste in order to meet the technological growth and satisfy human request. Industrial waste is defined as any solid, semisolid, or liquid that presents a considerable danger to people and the environment owing to its acidity and dangerous elements [2]. For instance, untreated garbage transfers poisonous and dangerous elements into the environment, which acts as an ideal environment for pathogenic bacteria, posing serious health risks [3]. Although, according to [4] industrial activities are extremely significant in view of fundamental changes in the human actions of an economic system.

The fast expansion of industry has resulted to a rise in the production of contaminated trash [5]. As an example, the electrical appliances production is known to generate enormous volumes of trash containing heavy metals [6]. Additionally, [7] mentioned that sludge has been considered as one of the most hard to manage due to its low solubility and high concentration of hazardous heavy metals.

In recent years, industrial waste management has become increasingly urgent in emerging countries due to economic growth, and the acceleration of consumption has caused an expansion in waste generation [8]. Poor waste management has polluted the world's water bodies, clogged sewers, caused flooding, and spread illnesses through vector breeding [9]. Also, it promotes increases in breathing concerns through particles in the air arising from garbage combustion, damage to species that feed waste unwittingly, and impacts on economic fall, such as lower tourism [10].

Many studies have been conducted to identify sustainable decision-making models to analyze industrial waste management solutions, such as life-cycle assessment (LCA), cost-benefit analysis, and multi-criteria decision analysis (MCDA) [11]. According to [12] life cycle assessment (LCA) will help the decision-maker select a suitable control strategy that has the least environmental impact. As [13] reported multi-criteria decision analyses was suitable for assessing the sustainability industrial waste management system. Furthermore, the United Nations Sustainable Development Goals (SDGs) 11 and 12 emphasize the sustainable management of industrial waste as well as recycling for the reuse of end-of-life (waste) materials as possible secondary resources [14].

This study aims at examining the most popular journals and cited articles, scientific production output, academic impacts of published papers.

MATERIAL AND METHOD

This paper aims to provide bibliometric and literature analyses in order to explore industrial waste management research globally. To extract the articles on the subject offered above, a keyword "industrial waste management" was searched from Dimensions database on May, 30 of 2024. Article search period included 2015-2024 years and limited by language “English”. Only open access and final published research articles were selected and database consisting of 160 papers was exported to a CSV file for further analyses on industrial waste management. Then, a database was categorized including the year of publication, academic impacts, source title. Figure 2 demonstrates the flow of the selected methodology for the research.

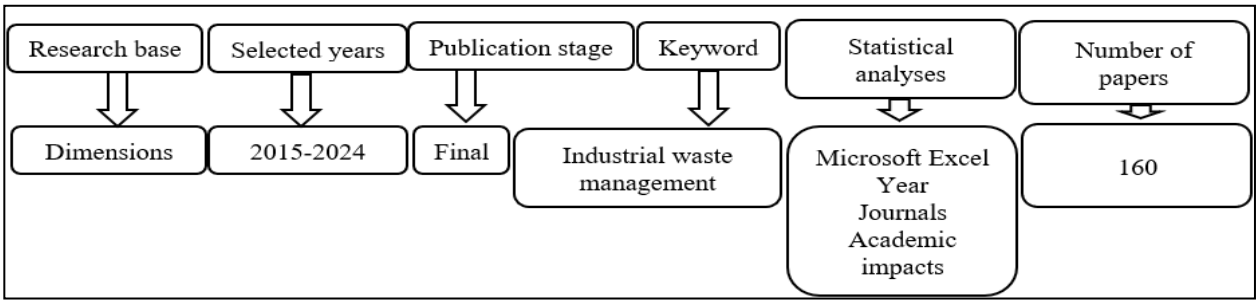

FIGURE 1. Methodology flowchart for the research

RESULTS

Scientific Production Analyses

A total of 160 articles on industrial waste management were published globally for the last 10 years (Figure 2). 2015 and 2016 were recognized as lowest production periods in the selected research contributing only 5 published papers each year. However, it was found that 2017 and 2019 had arisen almost three times with 14 articles, respectively. The highest point of scientific research output was 2021 with 45 (28%) published articles. The trend is going down from 2022 still today. As this analysis was carried out on May, 2024, it is possible to predict that current year scientific production output will have higher results than previous two years.

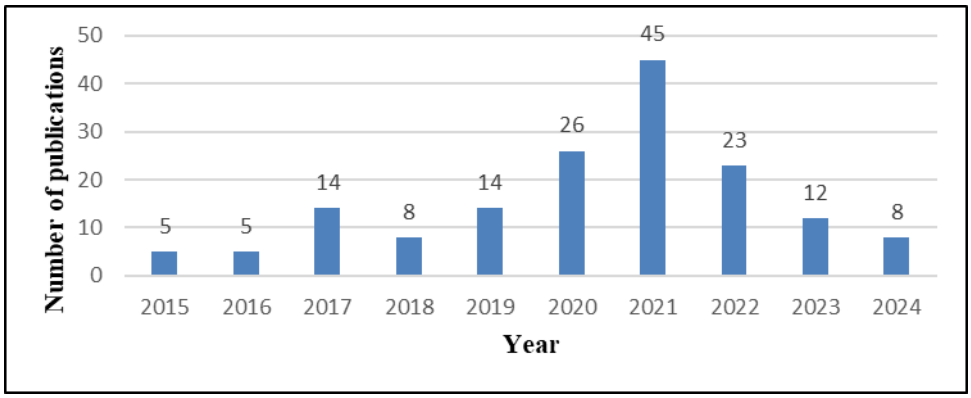

FIGURE. 2. Annual scientific production

Most Relevant Journals On Industrial Waste Management

Choosing the correct publisher is essential during the publication process. Dimensions based 160 papers on industrial waste management issue were distributed among 10 different journals between 2015-2024 (Table 1). Key journals on industrial waste management are "The Science of Th Total Environment", "Chemosphere" and "Journal of Cleaner Production" which contributed almost half of total published papers.

TABLE 1. List of the top journals on industrial waste management

Source title	Number	Source title	Number
The Science of The Total Environment	35	Environmental Research	13
Chemosphere	20	Environmental Pollution	13
Journal of Cleaner Production	20	International Journal of Hydrogen Production	10
Renewable and Sustainable Energy Review	18	Energy	10
Journal of Hazardous Materials	15	Energy Conversion and Management	6

Academic impact of published papers on industrial waste management

Well-known that academic impact is an important topic in the research world. It is often quantified using bibliometrics and citation counts, and it contributes to a researcher's h-index. This study investigated citation count, field citation ratio and relative citation ratio.

Total number of citations of 160 published papers on industrial waste management was 14431 having the top in 2023 (Fig. 3). The Field Citation Ratio (FCR) measures a publication's relative citation effectiveness when compared to similarly dated publications related to its topic area (Fig. 4). FCR for research period equals 12.72. The Relative Citation Ratio (RCR) measures a publication's relative citation effectiveness as compared to other papers in the same field (Fig. 5). RCR is 6.27 for the last 10 years.

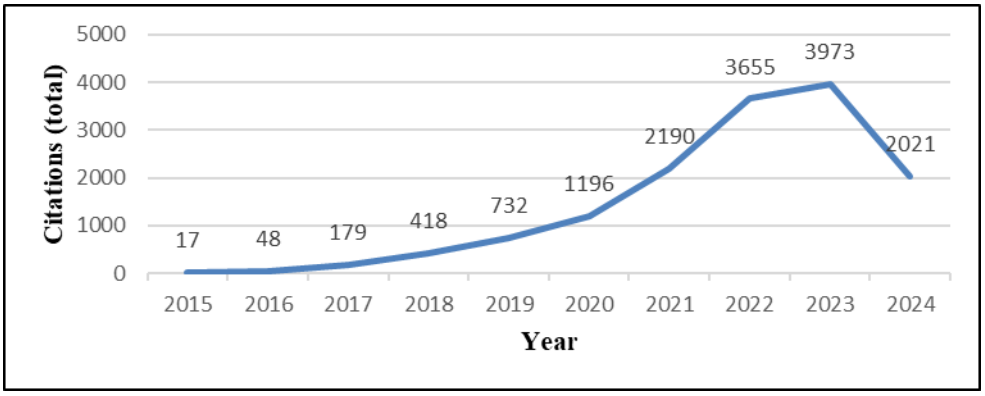

FIGURE 3. Citation distribution by the years

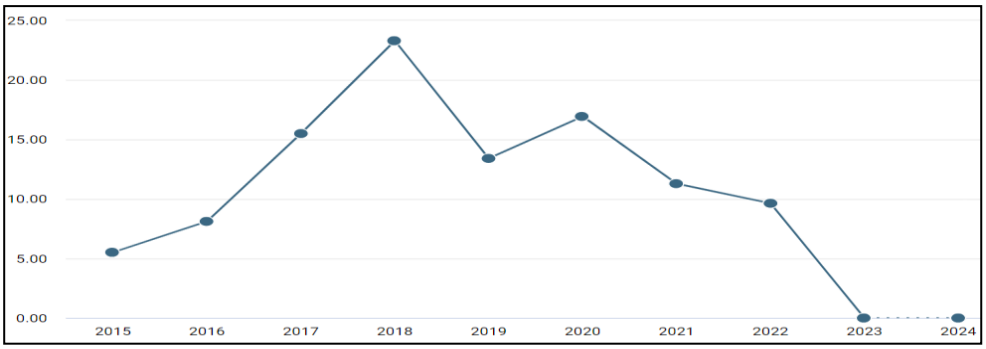

FIGURE 4. Field citation ratio

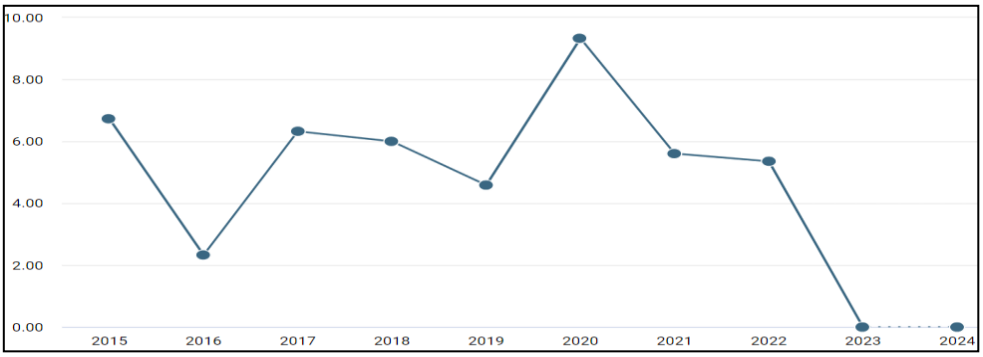

FIGURE 5. Relative citation ratio

Top Cited Papers On Industrial Waste Management

The number of citations indicates the quality and innovation of the research. Table 2 lists the ten most referenced publications on industrial waste management, along with their citation numbers, journals, year, relevance to Sustainable Development Goals.

TABLE 2. List of top cited papers on industrial waste management

№	Title	Citation	Journal	Year	Sustainable development goals
1	Advances in stationary and portable fuel cell applications	427	International Journal of Hydrogen Energy	2016	11 Sustainable Cities and Communities; 13 Climate Action; 7 Affordable and Clean Energy
2	Microplastics as pollutants in agricultural soils	410	Environmental Pollution	2020	2 Zero Hunger
3	Recent advances in carbon dioxide utilization	407	Renewable and Sustainable Energy Reviews	2020	13 Climate Action; 15 Life on Land
4	Environmental fate, toxicity and risk management strategies of nanoplastics in the environment: Current status and future perspectives	376	Journal of Hazardous Materials	2020	14 Life Below Water
5	A critical review on effects, tolerance mechanisms and management of cadmium in vegetables	364	Chemosphere	2017	2 Zero Hunger
6	Comprehensive investigation on hydrogen and fuel cell technology in the aviation and aerospace sectors	348	Renewable and Sustainable Energy Reviews	2019	13 Climate Action; 7 Affordable and Clean Energy
7	Developments of electric cars and fuel cell hydrogen electric cars	346	International Journal of Hydrogen Energy	2017	13 Climate Action; 7 Affordable and Clean Energy
8	Biorenewable hydrogen production through biomass gasification: A review and future prospects	321	Environmental Research	2020	7 Affordable and Clean Energy
9	Cadmium phytoremediation potential of Brassica crop species: A review	296	The Science of The Total Environment	2018	

10	Outlook of carbon capture technology and challenges	295	The Science of The Total Environment	2018	13 Climate Action

CONCLUSION

This study presents a bibliometric analysis of 160 scientific publications to evaluate the current landscape of research in the field of industrial waste management. The findings indicate that the volume of research output in this area remains relatively limited, reflecting its developmental stage. Utilizing data from the Dimensions database, we examined publication trends over the past decade and identified the leading journals publishing on this topic. Furthermore, we assessed the academic influence of the selected works through key metrics, including total citation count (14,331), Field Citation Ratio (12.72), and Relative Citation Ratio (6.27). The most highly cited articles were further analyzed to determine their contribution and relevance to the United Nations Sustainable Development Goals (SDGs).

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