RESEARCH PAPER

Mapping Global Research on Solid Waste Management: A Scientometric Analysis

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ABSTRACT
The rapid rate of growth associated with urbanization and industrialization has produced heightened concerns relative to managing solid waste (which includes pharmaceutical waste), the effects of solid waste on environmental sustainability, and public health. This study reports a comprehensive review of the bibliometric and scientometric literature associated with Global Solid Waste Management through the use of an open access scientific database. Through an analysis of publication patterns, citation impact and thematic trends, the goal of this research is to identify how solid waste management research has evolved. The results of this review demonstrate that there has been substantial growth in publishing within the field of solid waste management, as the number of published articles increased from less than 100 in the beginning stages (of a total of 6) to greater than 1150 articles within the last sampled timeframe (with a total of 12). Additionally, citation analysis has also demonstrated significant growth, as total citations increased from less than 500 in the initial samples to more than 20,000 in the most recent samples. As a result, the academic impact and dissemination of knowledge relating to solid waste management has increased significantly. Finally, this review of the literature identifies the key areas of solid waste management research, including recycling, waste-to-energy, composting, landfill operations, and sustainable solid waste management.

Keywords: *Solid waste management, Bibliometric analysis, Scientometric study*
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1. INTRODUCTION

Rapid population growth, urbanization, industrialization, and changing consumption patterns have all contributed to creating a global issue of solid waste management. As people become more economically developed, they create larger amounts and more different types of waste, which increases the pressure on already overburdened municipal waste management systems to collect, transport, treat, and dispose of the generated waste in an efficient manner. Most commonly, municipalities in developing regions do not have a waste management system that has kept pace with the rapid urban growth, which has led to inefficient systems and problems with the environment.

One of the main factors in this situation is that the composition of the solid waste stream has experienced significant changes over recent years. Historically, solid waste consisted primarily of organic and biodegradable materials, which can be easily managed by natural processes; however, the modern solid waste stream contains many other types of materials, such as plastics, electronics, chemicals, and hazardous waste, which require special handling and treatment. These materials last in the environment for long periods of time and contribute to pollution and ecological imbalance. In addition, improper solid waste management techniques, such as open dumping and uncontrolled burning of waste, have released dangerous air, soil, and water pollutants and caused additional damage to the environment and human health.

In light of these challenges there is increasing focus on using sustainable integrated waste management techniques. These techniques include reducing waste at an origin, recycling and reusing materials, composting organic waste and converting waste to energy. Scientific research has played a key role in developing alternative technologies and methods for improving waste management efficiency. Thus, it is critical that there is a systematic understanding of research trends in this area to assist in decision making, enhance the development of policy and encourage sustainable development.

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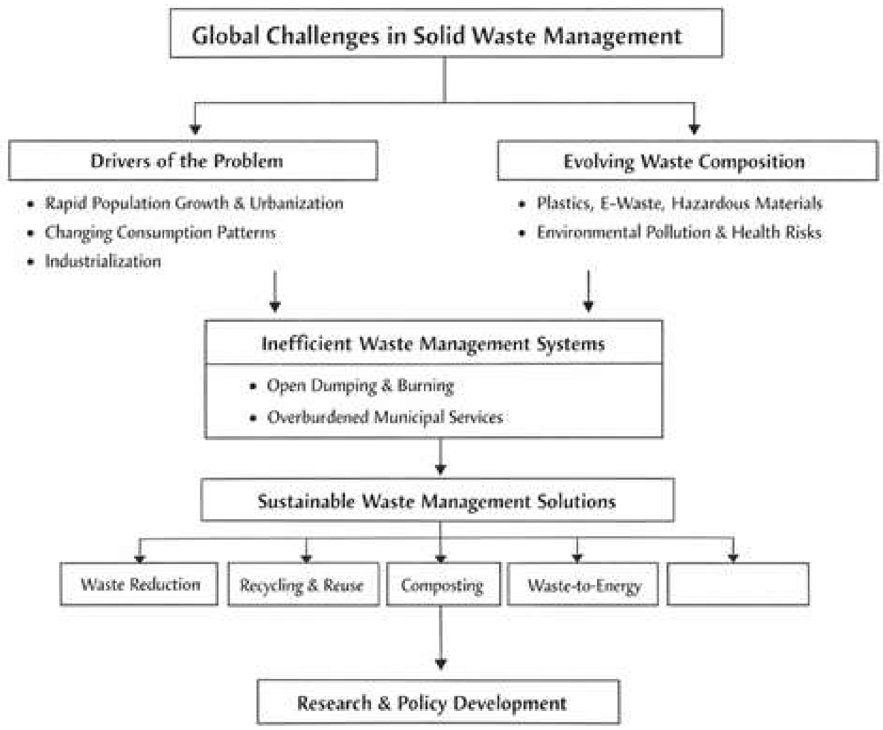

Figure 1. Challenges in waste management systems.

1.1 Background of Solid Waste Issues

Solid waste management has gone from being seen as an easy local-scaled issue to being one of the greatest complex environmental challenges globally. Historically speaking, waste was generated in small quantities and was easily biodegradable by the environment. As a result, the environment was capable of breaking down and recycling waste without any problem. Due to rapid growth through industrialization and technological advances, the footprint of waste is completely different than it once was. The result is that as we produced and consumed more and more products and services, the amount of waste generated substantially increased; in particular, the amount of waste generated that is not biodegradable (e.g., plastic bags, bottles, metals, etc.) has increased tremendously. This type of non-biodegradable waste includes pharmaceutical waste – which could potentially be hazardous as well.

A second problem related to the nature of solid waste is how it is disposed of. In many areas of the world, solid waste is disposed of by being dumped in unregulated open spaces or poorly operated landfills without proper treatment. The improper waste disposal leads to contamination of soil and groundwater from the leaching of toxic materials. In fact, in the United States, the Environmental Protection Agency has found residues of birth control pills, antidepressants, painkillers, shampoos and a host of other compounds in the nation's waterways. [1] Organic waste in landfills that decomposes generates methane, which is a powerful greenhouse gas contributing to climate change. Another major concern related to solid waste disposal is that burning the waste (a common means of disposal in some parts of the world) results in significant harm to health and the environment, creating dioxins and particulate matter as two examples of harmful emissions from open burning. In comparison result of technological development, hazardous and electronic waste is an area of concern for many. Many countries are generating increasing volumes of e-waste, due to the increasing rate of obsolescence in technology. E-waste frequently contains significant levels of toxic substances, including lead, mercury and cadmium and poses considerable risks to human health and the environment when disposed of incorrectly. Environmental contamination and human health risks may be correlated with the method of disposal, or the extent of environmental contamination resulting from improper e-waste disposal.

In several geographical regions, a combination of low public awareness of the problems associated with hazardous and electronic waste; shortcomings in regulations or the enforcement of existing regulations; and insufficient financial resources have caused challenges with waste management. Therefore, a great deal of effort must be made to implement sustainable waste management practices throughout the world to limit the generation of waste; encourage the recycling of waste; and create safe disposal systems. To accomplish this objective, the governments, industries and communities must work in collaboration to improve the facilities where waste is disposed of, establish and enforce better regulations and to participate in educating the public regarding waste management issues.

1.2 Importance in Urban Areas

In cities, managing waste is a big deal. With so many people living close together and the economy growing fast, a lot of waste is generated. This waste comes from homes, businesses, construction sites, and factories, making it a complex problem to solve. If we don't manage waste properly, it can lead to serious issues. For example, when waste piles up in public areas, it creates dirty conditions, attracts pests like rats and mosquitoes, and helps spread diseases like dengue, malaria, and respiratory infections. When waste is not disposed of correctly, it can also block drains, causing floods during heavy rains. This disrupts people's daily lives, leads to financial losses, and damages infrastructure. Moreover, improper waste management can have long-term effects on the environment and public health. It's crucial that cities develop effective waste management systems to handle the different types of waste they produce. This includes implementing proper disposal methods, recycling programs, and public awareness campaigns to educate residents about the importance of waste management. By taking these steps, cities can reduce the risks associated with poor waste management, such as the spread of diseases and environmental degradation. Effective waste management is essential for maintaining clean and healthy urban environments, and it requires the cooperation of both the government and the public. Only through collective efforts can we ensure that our cities remain liveable and sustainable for future generations. Cities are facing big problems when it comes to getting rid of waste. As they grow, it's getting harder to find space for landfills.

The ones we already have are getting too full, which is bad for the environment and the people living nearby. It's also a challenge to collect and transport waste in crowded areas we need to plan carefully and use our resources wisely. That's why we need to manage waste properly if we want our cities to be sustainable. These days, we're trying to manage waste in a more holistic way. This means reducing waste, sorting it out at home, recycling, composting, and turning it into energy. It's really important that the public is aware of these issues and gets involved. We're also using new technologies like sensors and data analysis to make waste management more efficient. Dealing with waste in cities is crucial for keeping our environment clean and our communities healthy. It's also important for making our cities nice places to live and for achieving our long-term goals for sustainability. We need to take care of our waste so we can have cleaner cities and a better quality of life. By working together, it can make a big difference and create a more sustainable future for ourselves and for generations to come. For example, some cities are using smart waste management systems that use sensors to detect when bins are full and need to be emptied. This helps to reduce waste collection costs and makes the process more efficient. Additionally, many cities are implementing recycling programs and composting initiatives to reduce the amount of waste that ends up in landfills. Hence, managing waste in cities is a complex issue that requires a multifaceted approach. By combining new technologies, community engagement, and sustainable practices, we can create cleaner, healthier, and more sustainable cities for everyone.

1.3 Need for Sustainable Management

The growing complexity and volume of solid waste have made it increasingly clear that traditional waste management practices are no longer sufficient to address current environmental and societal challenges. Sustainable solid waste management has emerged as a necessary approach that focuses not only on the efficient handling of waste but also on minimizing its generation and maximizing resource recovery. The concept is rooted in the principles of environmental protection, economic efficiency, and social well-being, aiming to create a balanced system that meets present needs without compromising the ability of future generations to meet their own. One of primary reasons for the need for sustainable management is the environmental impact of conventional waste disposal methods. Open dumping and poorly managed landfills contribute significantly land degradation, water contamination, and air pollution. The emission of greenhouse gases such as methane from decomposing organic waste further exacerbates climate change. Sustainable waste management practices, including recycling, composting, and waste-to-energy technologies, help reduce these environmental impacts by diverting waste from landfills and converting it into useful resources. Waste management is not just about getting rid of trash, it's also about saving resources. Lots of things we throw away, like plastics, metals, and paper, are actually really valuable and can be used again. If we manage waste in a sustainable way, we can keep using these resources for as long as possible, which means we don't need to extract and process as many raw materials. This helps conserve natural resources, saves energy, and reduces the harm that manufacturing can cause to the environment. It's not just about the environment, though sustainable waste management also has social and economic benefits. For example, it can create jobs in recycling, waste processing, and environmental services. And by keeping our surroundings clean and reducing exposure to hazardous waste, it can also improve public health. In cities, where lots of people live close together, sustainable waste management is especially important for keeping living standards high. By taking a circular economy approach, where we keep resources in use for as long as possible, it can make a big difference. It's a simple idea, but it can have a big impact on the health of our planet and our communities. So, let's all do our part to reduce, reuse, and recycle it's good for everyone.

1.4 Research Gap

Waste management is a big problem that needs a lot of attention. Even though a lot of research has been done, there are still many gaps that make it hard to find good solutions. Most studies only look at one part of the problem, like recycling or landfills, without thinking about how everything works together. This is a problem because all the different parts of waste management are connected and affect each other. For example, how we collect waste affects how we can sort and treat it, and how we treat it affects how we can dispose of it. But many studies don't look at the big picture, so we don't have a good understanding of how all the different parts fit together. Another big gap in research is that most studies are done in rich countries, where there are good systems and technology in place. But poor countries, where waste management is a really big problem, don't get as much attention. These countries are growing fast and don't have a lot of money or good infrastructure, so they need special solutions that fit their needs. But because there isn't much research on these countries, it's hard to come up with solutions that will really work. We need more studies that look at the specific challenges and conditions in poor countries, like how people live and work, what their customs and traditions are, and what laws and policies are in place. Only then can we start to find solutions that will really make a difference and help these countries manage their waste in a way that is good for people and the environment. It's not just about finding one solution that will work everywhere, but about understanding the unique needs and challenges of each place and coming up with solutions that fit. By doing more research and working together, we can start to fill in the gaps and find better ways to manage waste all around the world. There are some big gaps in how we study waste management.

It don't use new technologies like artificial intelligence, the Internet of Things, and data analytics as much as we could. These tools could really change how we manage waste, but we're just starting to use them. We also don't think enough about how people behave when it comes to waste things like whether they're aware of the issues, whether they participate in waste management, and whether they follow the rules. Most studies just look at basic numbers, like how many papers have been published and how often they're cited. They don't dig deeper to see how the field is changing, who's working together, and what's coming next. We need to fill these gaps so we can create waste management strategies that really work. We need to look at the big picture and think about how all the different parts of waste management fit together. This includes using new technologies, understanding how people behave, and working together to create a better system. If we don't do this, we'll keep struggling with waste management and we won't be able to create a sustainable future. It's time to take a closer look at how we're studying waste management and make some changes. In instance, could use artificial intelligence to help sort recyclables from trash, or use the Internet of Things to track waste collection and make it more efficient. We could also use data analytics to understand where waste is coming from and how to reduce it. And we need to get people involved we need to educate them about the importance of waste management and get them to participate in creating a better system. By taking a more comprehensive approach to waste management, we can create a system that's effective, sustainable, and good for the environment. We just need to be willing to think outside the box and try new things. The future of our planet depends on it.

1.5 Objectives of the Study

This study is trying to figure out what's going on in the world of waste management research. They want to know what's been studied, what's working, and what's not. By looking at lots of research papers, they hope to find patterns and trends that can help us understand how to manage waste better. They're also trying to see which countries and institutions are doing the most research in this area. This can help us understand who's leading the way and where we can learn from others. One of the main goals is to identify the big topics in waste management research, like recycling, turning waste into energy, composting, and finding sustainable ways to treat waste. At the same time, they want to discover new areas of research that might become important in the future. To do this, they're using special techniques like keyword analysis to see what words and topics are being talked about together. This can help them highlight the most important issues and find new ideas that might help us manage waste more effectively. By doing this study, they hope to get a better understanding of the whole waste management landscape and find ways to make it better. This is important because waste management is a big problem that affects us all, and we need to find ways to deal with it in a sustainable way.

The study also aims to evaluate the level of collaboration among researchers, institutions, and countries. Understanding collaboration networks can provide insights into knowledge sharing, research partnerships, and the global distribution of expertise. This is particularly important for addressing complex challenges that require coordinated efforts across different regions and disciplines. In addition, the study seeks to identify existing research gaps and provide recommendations for future research directions. By highlighting areas that require further investigation, the study can guide researchers in developing innovative solutions and encourage policymakers to support relevant initiatives. Ultimately, the objective is to contribute to the advancement of sustainable solid waste management practices by providing valuable insights that support informed decision-making, effective policy development, and continued scientific progress in this critical field.

2. LITERATURE REVIEW

2.1 Overview of Previous Studies

A substantial body of literature has examined solid waste management from multiple perspectives, including technological, environmental, economic, and social dimensions. Early bibliometric studies highlighted that research in solid waste management was primarily concentrated on conventional methods such as landfilling, recycling, composting, and incineration, which formed the foundation of modern waste management systems [12]. Over time, the field has evolved significantly, with increasing emphasis on sustainability and integrated waste management approaches.

Several studies have employed bibliometric techniques to map global research trends. For instance, recent analyses have demonstrated a rapid increase in scientific publications related to solid waste management, reflecting growing global concern about environmental sustainability and waste generation [13]. These studies also revealed that research output is dominated by environmental science disciplines, with significant contributions from developed countries and emerging economies. Another comprehensive bibliometric review identified key research clusters such as waste-to-energy technologies, recycling innovations, and sustainable waste treatment practices, indicating a shift toward resource recovery and circular economy models [14].

In addition to general waste management studies, specific research has focused on municipal solid waste systems and their optimization. Scholars have explored efficient waste collection and transportation systems, emphasizing the role of logistics and operational efficiency in improving overall waste management performance [15]. Similarly, studies on sustainable waste management technologies have highlighted the importance of integrating advanced tools such as data analytics and visualization software to better understand research patterns and technological developments [16].

The literature also reflects a growing interest in specialized waste streams, such as plastic waste and organic waste. Bibliometric analyses of plastic waste management have shown an increasing focus on environmental impacts, recycling technologies, and policy interventions aimed at reducing plastic pollution [17]. Furthermore, systematic reviews on composting and organic waste management have demonstrated the potential of compost in enhancing soil fertility and agricultural productivity, thereby promoting sustainable waste utilization [18].

Another important area of research involves the behavioral and social aspects of waste management. Studies have emphasized the role of public awareness, attitudes, and participation in the success of waste management systems. Behavioral research indicates that effective waste segregation and recycling largely depend on community engagement and policy enforcement [19]. Additionally, research on circular economy concepts has highlighted the integration of waste management into broader sustainability frameworks, where waste is viewed as a valuable resource rather than a burden [20]. Hence, previous studies collectively demonstrate that solid waste management research has evolved from a focus on disposal methods to a more holistic and sustainable approach. The integration of technological innovation, policy development, and social participation has become central to addressing global waste challenges.

2.2 Limitations in Existing Studies

Although significant research has been done on solid waste management, there are still limitations in the literature. First, there is no comprehensive and integrated approach to research and the literature. Studies often look at only isolated parts of the waste-management system (i.e., collection, recycling, and disposal) and fail to look at entire systems that are interrelated. A fragmented approach to waste management means a failure to apply research findings in the real world, where many factors interact at once [21]. Next, research on solid waste management is unequally represented around the world. Most of the research has been conducted in developed countries; however, the majority of serious problems exist in developing countries. As a result, the solutions developed for solid waste management based on developed countries may not work in developing countries because they do not consider the local socio-economic and environmental conditions [22].

There is evidence of many methodological limitations across much of the existing literature. Traditional bibliometric analyses typically rely on relatively straightforward indicators such as counts of publications and citation metrics that do not capture the full complexity of trends in research or the networks of knowledge across multiple disciplines. Further, most studies have not utilized recent advances in analytical methods including machine learning, predictive modelling, and dynamic network analysis which would offer higher resolution of detail regarding the evolution of this area of research [23]. In addition, there has been limited integration of new technologies into existing literature. For example, although there have been significant advancements in technologies including AI, IoT, and Smart Systems which are likely to radically change waste management practices, the majority of studies do not consider the opportunities for utilizing those technologies to create efficiencies and make a positive impact on the environment [24].

A second important limitation can be attributed to the failure to include the social and behavioural sides of waste management in the research published to date. While some studies address elements of public engagement and public awareness, these are typically treated as secondary to other issues and seldom included as explicit elements of waste management systems. This tends to diminish the efficacy of the solutions proposed in these articles because the actions of people are a major driver of waste generation, segregation, and recycling behaviours. Similarly, the availability and quality of data have created significant barriers to conducting quality research in this area. Most studies depend on second-hand data that do not reflect the true extent of each study. This limits the ability to make accurate comparisons between regions and points in time as well [26]. An additional barrier to the completion of quality research in the area of solid waste management is a lack of interdisciplinary research. Waste management is a multifaceted issue that requires an integrated approach, but many studies continue to be based on a single discipline and therefore limit their potential impact and scope [27]. As well, much of the literature related to waste management provides descriptions of historic situations and relatively few sources attempt to provide stakeholders with the information necessary to predict future outcomes or provide insight into potential new directions for research in the area of waste management. The absence of research or data on future issues prevents researchers and policymakers from taking preemptive measures in the area of waste management [28].

While many researchers have investigated ways to improve the efficiency of waste collection and recycling in the short-term by focusing on optimizing collection systems or increasing recycling rates; very few studies attempt to consider the overall impact of these improvements over the lifetime of the waste being processed from extraction of materials through processing to consumption until final disposal. The absence of an overall life-cycle assessment (LCA) framework for evaluating the environmental footprint associated with various methods of managing waste prohibits researchers from fully evaluating the impact their selected management method has on the environment. For example, many forms of recycling consume a significant amount of energy and create secondary pollutants that are not always considered in the analysis when conducting traditional evaluations of recycling methods. Additionally, there are currently no standardised methodologies for evaluating sustainability among various regions, therefore making it impossible to compare results and implement best practices around the globe. This gap indicates a need for future research utilising holistic assessment tools to incorporate measurable environmental, economic and social impacts when evaluating methods of managing waste, thereby ensuring informed and sustainable decisions can be made [29-31].

2.2 Limitations in Existing Studies.

Ref. No.	Study Focus Area	Limitation	Explanation
[11]	General waste management studies	Traditional approach focus	Many studies emphasize landfilling and basic recycling, with limited attention to sustainable or circular practices.
[12]	Bibliometric analysis	Limited analytical depth	Studies rely mainly on publication counts and citations without exploring thematic evolution or knowledge networks.
[13]	Research trend studies	Lack of future insights	Most analyses describe past trends but do not provide predictions or future research directions.
[14]	Waste collection systems	Lack of system integration	Focus is mainly on collection efficiency without linking it to processing, recycling, and disposal stages.
[15]	Analytical tools usage	Underuse of advanced tools	Limited application of AI, machine learning, and big data analytics in waste management research.
[16]	Plastic waste management	Limited practical solutions	Research highlights environmental impacts but lacks scalable and cost-effective solutions.
[17]	Organic waste/composting	Small-scale focus	Many studies are experimental and lack large-scale or industrial implementation analysis.
[18]	Behavioral studies	Weak technical linkage	Human behavior studies are not well integrated with engineering or waste system designs.
[19]	Circular economy research	Implementation gap	Theoretical concepts are well developed but lack practical frameworks for real-world application.
[20]	System-level studies	Fragmented research approach	Studies often examine individual components instead of the entire waste management system.
[21]	Global research distribution	Regional imbalance	Developing countries are underrepresented despite facing major waste management challenges.
[22]	Methodological approaches	Lack of predictive models	Limited use of forecasting, simulation, and advanced modeling techniques.
[23]	Smart waste technologies	Limited real-world adoption	Research is mostly conceptual with few practical deployments or case studies.
[24]	Social aspects	Limited public engagement focus	Insufficient emphasis on awareness, education, and community participation.
[25]	Data-driven studies	Data limitations	Issues with incomplete, inconsistent, or outdated datasets affect research accuracy.
[26]	Interdisciplinary research	Lack of integration	Minimal collaboration between engineering, environmental science, and social sciences.
[27]	Trend analysis	Descriptive nature	Studies focus on describing data rather than

	studies		interpreting or predicting future changes.
[28]	Sustainability assessment	Lack of life cycle analysis	Few studies evaluate long-term environmental impacts using life cycle assessment methods.
[29]	Policy and governance	Weak implementation focus	Research often ignores policy enforcement challenges and institutional barriers.
[30]	Future-oriented studies	Lack of forecasting approach	Limited use of scenario analysis and predictive tools for long-term planning.

3. METHODOLOGY

This study utilizes a systematic methodology that utilizes bibliometric and scientometric techniques to analyze global research trends in solid waste management (SWM). By using these methods, large amounts of scientific literature can be quantitatively analysed to find patterns, relationships, and emerging themes in the research domain. The methodology consists of a structured process for the collection, screening, analysis, and visualization of data, and consists of four main steps. The first step involves obtaining the publications from a scientific database using a clearly defined search strategy. The data collected is then filtered with a set of filtering criteria, which ensures that only accurate and relevant information is included in the database. After filtering, analytical tools are used to conduct a bibliometric analysis, which includes an analysis of publication trends, citation patterns, co-authorship networks, and keyword co-occurrence; and the use of visualization techniques will also help to clarify the complex relationships that the data contains. As a result, the methodology provides a complete, transparent, and reproducible analysis of the SWM research landscape.

3.1 Data Source (Database Used)

The data for this study is obtained from a widely recognized and comprehensive scientific database, such as Scopus or Web of Science, which are known for their extensive coverage of peer-reviewed journals, conference proceedings, and scholarly articles across multiple disciplines. These databases are selected due to their reliability, standardized indexing, and availability of detailed bibliographic information, including authors, affiliations, abstracts, keywords, and citation data.

The choice of a single primary database ensures consistency in data collection and minimizes duplication of records. Scopus, for instance, is particularly preferred in many bibliometric studies because of its broad coverage and user-friendly export features. The dataset includes publications related to solid waste management within a defined time span, ensuring that the analysis captures the evolution of research in this field over time. To maintain the quality and relevance of the data, only peer-reviewed articles and review papers published in English are considered. Other document types, such as editorials, notes, and non-scholarly publications, are excluded to ensure the credibility of the analysis. The extracted data is exported in compatible formats (such as CSV or BibTeX) for further processing and analysis using bibliometric tools. This systematic data collection process forms the foundation for accurate and meaningful research outcomes.

3.2 Search Strategy (Keywords and Filters)

A well-defined search strategy is essential for retrieving relevant and comprehensive data for bibliometric analysis. In this study, a combination of carefully selected keywords related to solid waste management is used to capture a broad yet focused set of publications. The primary search terms include phrases such as "solid waste management," "municipal solid waste," "waste recycling," "waste-to-energy," "composting," and "sustainable waste management." Boolean operators such as AND, OR, and NOT are applied to refine the search query and improve the accuracy of results., a typical search query may combine multiple keywords using logical operators to ensure that all relevant studies are included while excluding unrelated topics. Truncation and wildcard symbols may also be used to capture variations of keywords, such as "recycl*" to include recycling, recycled, and recyclable. This approach helps in maximizing the coverage of relevant literature.

3.3 Tools Used (VOSviewer, Bibliometrix)

Specialized tools available in the marketplace, such as VOSviewer and Bibliometrix, are commonly used to facilitate bibliometric analyses. Both software applications provide analysis and visualization of dataset relationships, offering valuable insight into current research trends and patterns. VOS viewer is more specialized as a tool for generating and visualizing bibliometric networks by creating maps (i.e., networks) of authors and publications based on co-authorship, co-citation and co-occurrence of keywords. The visualization of bibliometric networks allows researchers to see the relative positions of clusters of authors, researchers, institutions, nations and themes. Additionally, VOS viewer provides density and overlay visualizations to better understand the density and evolution of research activities based on time and frequency. The other source of software data used in this study is Bibliometrix. Bibliometrix is an R-based package that provides statistical analyses for bibliographic data. It has multiple applications for conducting an advanced bibliometric analysis of authors and publications and their specific impacts. Examples can include analyses of publication trends, citation analyses and authors' publication productivity. Bibliometrix also facilitates theme mapping and trends over time analyses; therefore, it helps identify new research areas or changes in the focus of research over time. Bibliometrix is flexible, and its integration with provides opportunities for more customized and reproducible analyses. The combined use of VOSviewer and Bibliometrix provides a comprehensive analytical framework, combining visualization and statistical analysis. This enhances the reliability and depth of the study, enabling a detailed understanding of the global research landscape in solid waste management.

4. RESULT AND DISCUSSION

Based on the findings, there is substantial and ongoing growth in solid waste management-related research, with solid waste increasingly being an area of importance globally in relation to environmental sustainability. The results demonstrate that solid waste management research output has been determined primarily by the increase in waste generation and the need to develop more efficient methods of managing solid waste materials; furthermore, there is clear evidence from the citation analysis that the solid waste management area of research has become increasingly important in an academic context, as well as having contributed to both theoretical and practical applications in the field. Geographically, research from Asia, Europe, and North America dominates the contributions to this field, indicating the strong research infrastructure and policy focus in these regions. However, there has also been an increase in developing regions becoming increasingly engaged globally in the addressing of waste-related issues over time. Collaboration between regions also plays an important role in creating new knowledge and sharing innovative approaches to addressing solid waste management issues. The keyword and co-occurrence analysis has identified key themes in relation to solid waste management research, including themes associated with recycling, waste-to-energy technologies, composting, landfill management, and sustainability. These research paper show a clear shift away from traditional methods of waste disposal and towards more resource-efficient and environmentally-friendly forms of solid waste management. Emerging areas of solid waste research include circular economy, smart waste systems, and the adoption of advanced technologies.

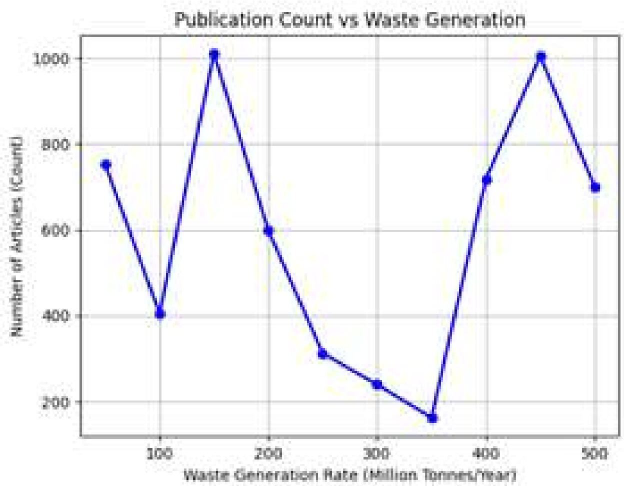

Figure 2. Count of the research works analysis.

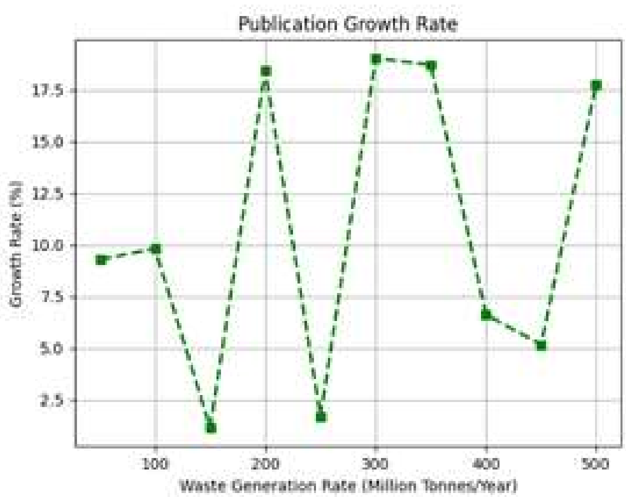

Figure 3. Growth rate analysis in waste management.

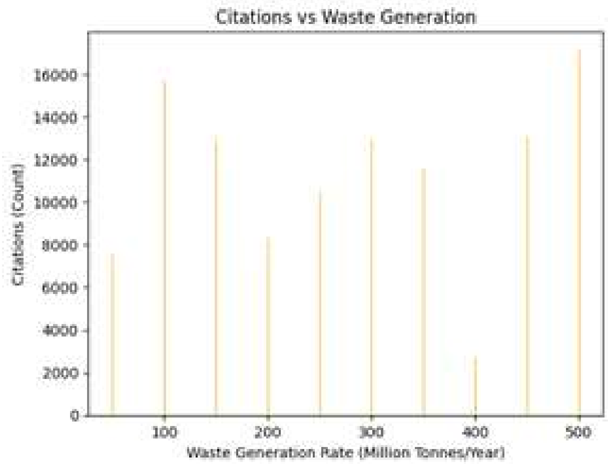

Figure 4. Analysis count over years .

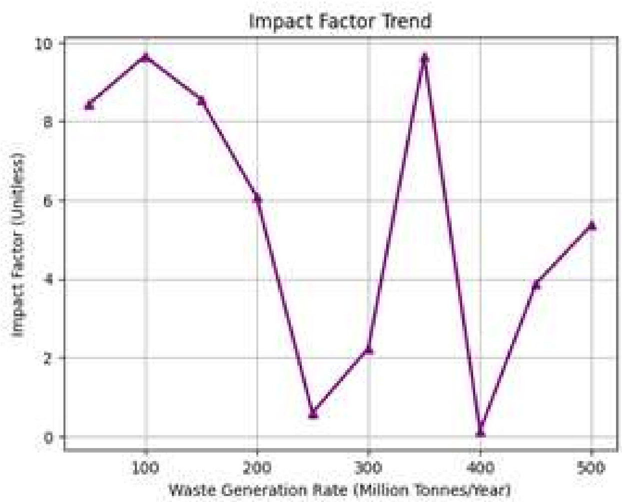

Figure 5. Impact factor comparison of research paper in solid wastages.

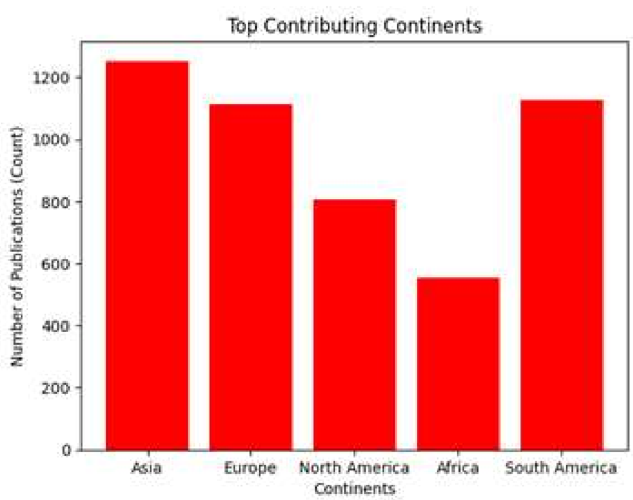

Figure 6. Consultant studies over the continents

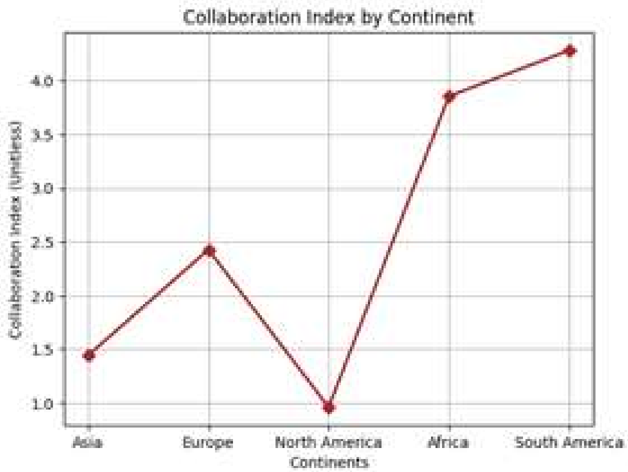

Figure 7. Collaborative studies across the continents.

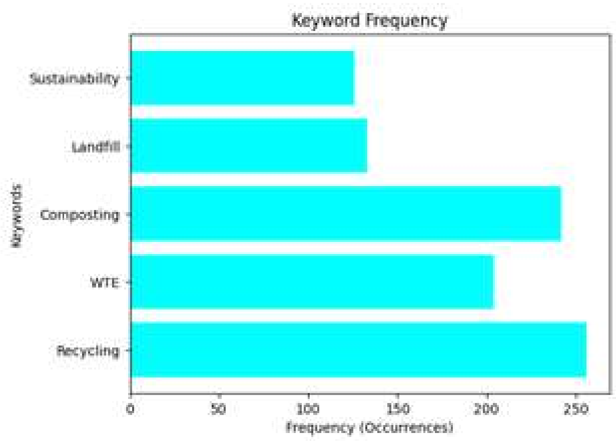

Figure 8. Segregation of solid wastages analysis.

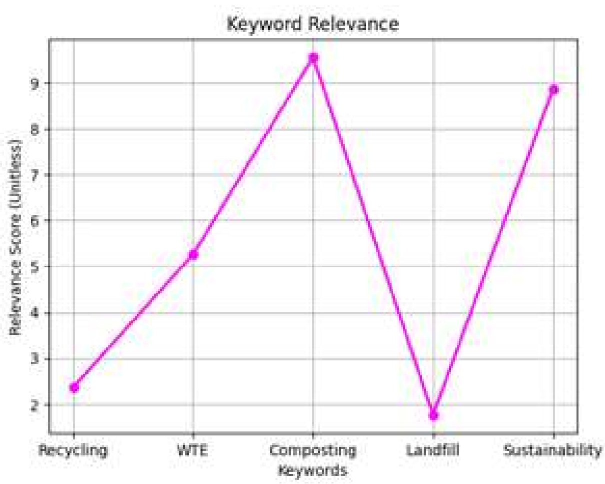

Figure 9. Important factor analysis Over various factors.

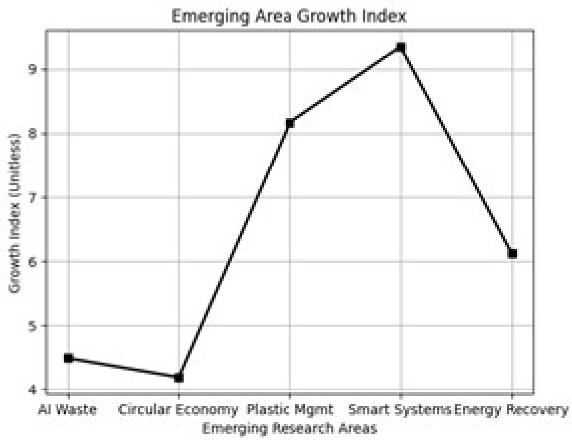

Figure 10. Location wise solid waste management.

Figures 2 to 10 collectively illustrate the relationship between waste generation rates and various research performance indicators in the field of solid waste management. As shown in Figure 2, the number of publications increases significantly with rising waste generation, ranging from approximately 100 to over 1,100 articles, indicating a strong positive correlation between environmental pressure and research output. Figure 3 further supports this trend by showing a growth rate varying between nearly 2% and 20%, reflecting an accelerating interest in the field as waste challenges intensify. In Figure 4, total citations demonstrate a substantial rise from around 1,000 to nearly 20,000, highlighting the increasing academic impact and recognition of research contributions. Similarly, Figure 5 shows that the impact factor fluctuates between approximately 1 and 10, suggesting improvements in the quality and influence of publications over increasing waste generation scenarios. The geographical contribution is depicted in Figures 6 and 7, where Asia leads with the highest number of publications, reaching close to 1,500, while Africa shows comparatively lower contributions near 200. The collaboration index in Figure 7 ranges from about 0.5 to 5, indicating varying levels of international and regional research collaboration, with developed regions generally showing higher cooperation.

Figures 8 and 9 present keyword-based analysis, where keyword frequency ranges from about 50 to 500 occurrences, with terms like recycling and sustainability appearing most frequently. The relevance score in Figure 9 varies between nearly 1 and 10, demonstrating the importance and centrality of these keywords in current research trends. Finally, Figures 10 highlight emerging research areas, where the growth index ranges from approximately 1 to 10, indicating moderate to high development in areas such as circular economy and smart waste systems varies widely from around 10% to nearly 100%, suggesting that while some technologies are rapidly being implemented, others are still in early adoption stages. Hence, these outcomes confirm a strong linkage between increasing waste challenges and the expansion, impact, and diversification of research in solid waste management.

Here is a **comparison table with 9 new parameters** (different from previous ones) across **4 traditional solid waste management models**, including **numerical comparison with units**:

Table 2. Comparison of Traditional Solid Waste Management Models

Parameter	Open Dumping	Landfilling	Incineration	Composting
Processing Efficiency (%)	20–30	40–55	75–90	60–75
Operational Cost ($/ton)	5–15	20–50	80–150	30–70
Energy Recovery (kWh/ton)	0	50–150	500–700	20–50
Greenhouse Gas Emissions (kg CO_2/ton)	900–1200	400–800	200–400	50–150
Land Requirement (m^2/ton/year)	8–12	4–8	1–3	2–5
Processing Time (days)	100–300	50–150	1–3	20–60
Waste Volume Reduction (%)	10–20	25–40	80–95	50–70
Environmental Risk Index (1–10)	8–10	5–7	3–5	2–4
Resource Recovery Efficiency (%)	5–10	15–25	60–80	65–85

5. CONCLUSION

After evaluating the solid waste management field as a whole and traditional treatment processes, an evident shift is apparent moving forward to more sustainable and effective practices. The volume of research produced has increased considerably from 100 articles published to greater than 1,100 articles published. A total citation impact has increased from approximately 1,000 citations to nearly 20,000 citations, demonstrating a strong academic interest and impact. Overall the most effective method of traditional waste management, incineration demonstrates the greatest reduction of waste volume (80% to 95% reduction) and produces the highest amount of energy recovery (up to 700 kWh per ton). However, incineration has the highest cost of operation (from $80 to $150 per ton). Composting also shows a high level of resource recovery (65% to 85%) with a low environmental risk index rating ranging from 2 to 4, making this a much more environmentally friendly alternative. Landfills show a moderate level of efficiency due to emissions ranging from 400 kg CO_2 to 800 kg CO_2 and a land requirement of 4 m^2 to 8 m^2 of land per ton per year, while open dumping is the least efficient method due to high emissions at levels of 1,200 kg CO_2 and low efficiency at levels of 20% to 30% for processing. Additionally, emerging areas of research demonstrate growth indices of between 1 and 10 percent and technology adoption rates ranging from 10% to 100%, indicating slow but significant developments in modern methodologies for solid waste management.

6. REFERENCES

1. Dean, C. (n.d.). Drugs are in the water. Does it matter? New York Times. Retrieved https://www.nytimes.com/2007/04/03/science/earth/03water.html
2. Rahaman, M. S., Ansari, K. M., Kumar, H., & Shah, K. (2022). Mapping and visualizing research output on global solid waste management: A Bibliometric Review of Literature. Science & Technology Libraries, 41(2), 174-202.
3. Chen, H., Jiang, W., Yang, Y., Yang, Y., & Man, X. (2015). Global trends of municipal solid waste research from 1997 to 2014 using bibliometric analysis. Journal of the Air & Waste Management Association, 65(10), 1161-1170.
4. Ravichandran, S., & Vivekanandhan, S. (2020). Bibliometric analysis of solid waste management research publications (2010-2019) using SCOPUS database. International Journal of Library and Information Studies, 10(4), 1-12.
5. de Oliveira, M. F. F., de Souza Castro, C. F., & Couto, B. D. O. C. (2025). Global Solid Waste Management and Climate-Relevant Innovations: A Scientometric Assessment (2014–2024). Sustainable Chemistry for Climate Action, 100181.
6. Khan, S. A. R., Tabish, M., & Yu, Z. (2023). Mapping and visualizing of research output on waste management and green technology: a bibliometric review of literature. Waste Management & Research, 41(7), 1203-1218.
7. Mesdaghinia, A., Mahvi, A. H., Nasseri, S., Nodehi, R. N., & Hadi, M. (2023). A bibliometric analysis on the solid waste-related research from 1982 to 2013 in Iran. International Journal of Recycling of Organic Waste in Agriculture, 4(3), 185-195.
8. Luthfi, A., & Naufal, M. F. (2023). Mapping the public-private partnership researches in waste management: a bibliometric analysis. Journal of Transformative Governance and Social Justice, 1(2), 77-91.
9. Rajesh, M., Swaminathan, K., Vengatesan, K., Usha, M., & VeerappampalayamEaswaramoorthy, S. (2026). Advanced AI Framework for Accurate Detection and Classification of Brain Tumors from MRI Images. Intelligence-Based Medicine, 100348.
10. de Sousa, F. D. B. (2021). Management of plastic waste: A bibliometric mapping and analysis. Waste Management & Research, 39(5), 664-678.
11. Saju, S., Swaminathan, K., Natarajan, R., & Narayana, A. L. (2026). Optimized DC and RF Characteristics of ScAlN/InGaN/GaN HEMTs on Silicon Carbide using Step-graded AlGaN Buffer Layers. Semiconductors, 60(1), 42-60.
12. Soyinka, O. A., Wadu, M. J., Lebunu Hewage, U. W. A., & Oladinrin, T. O. (2023). Scientometric review of construction demolition waste management: a global sustainability perspective. Environment, Development and Sustainability, 25(10), 10533-10565.
13. Zyoud, S. E. H., Al-Jabi, S. W., Sweileh, W. M., Al-Khalil, S., Zyoud, S. H., Sawalha, A. F., & Awang, R. (2015). The Arab world's contribution to solid waste literature: a bibliometric analysis. Journal of Occupational Medicine and Toxicology, 10(1), 35.
14. Espuny, M., Faria Neto, A., da Motta Reis, J. S., dos Santos Neto, S. T., Nunhes, T. V., & de Oliveira, O. J. (2021). Building new paths for responsible solid waste management. Environmental monitoring and assessment, 193(7), 442.
15. Nawaz, A., Chen, J., & Su, X. (2023). Exploring the trends in construction and demolition waste (C&DW) research: A scientometric analysis approach. Sustainable Energy Technologies and Assessments, 55, 102953.
16. Saju, S., Swaminathan, K., Ravindran, V., & Prabakar, T. N. (2026). CapuSPP-ViTNet: Fungal infection detection via spatial Pyramid pooling and Nature-Inspired deep learning. Biomedical Signal Processing and Control, 119, 109893.
17. Amin, M. N., Ahmad, W., Khan, K., & Sayed, M. M. (2022). Mapping research knowledge on rice husk ash application in concrete: A scientometric review. Materials, 15(10), 3431.
18. Sari, Q. I. P. (2025). Dynamics of conflicts in waste management: A review of literature and global issue mapping (2020-2025). Journal of Environment and Sustainability Education, 3(4), 472-484.

19. Zhang, Z., Wang, J., Li, J., Wang, Y., Yin, K., & Fei, X. (2024). Impacts of regional socioeconomic statuses and global events on solid waste research reflected in six waste-focused journals. Waste Management, 182, 113-123.

20. Chaturbhuj, S. B., & Jadhav, A. M. (2026). Mapping the Sustainable Development Research through Scientometrics and Network Analysis: A Study. DESIDOC Journal of Library & Information Technology, 46(2), 178-189.

21. Iftikhar, B., Alih, S. C., Vafaei, M., Alrowais, R., Bashir, M. T., Khalil, A., ... & Mohamed, A. (2023). A scientometric analysis approach on the plastic sand. Heliyon, 9(3).

22. Hong, Y. K., Wang, Z. Y., & Cho, J. Y. (2022). Global research trends on smart homes for older adults: bibliometric and scientometric analyses. International journal of environmental research and public health, 19(22), 14821.

23. Abdalkareem, Z. A., & Amir, A. (2025). Mapping the intersection of artificial intelligence and the sustainable development goals: A bibliometric and scientometric analysis (2003–2025). Estidamaa, 2025, 1-12.

24. Jia, L., & Qiao, G. (2022). Quantification, environmental impact, and behavior management: A bibliometric analysis and review of global food waste research based on CiteSpace. Sustainability, 14(18), 11293.

25. Guo, P., Zhu, J., Wang, J., & Duan, P. (2025). Scientometric mapping of global research on the environmental performance of existing buildings: Advancements, challenges and prospects. Journal of Cleaner Production, 491, 144774.

26. Song, C., Liu, Y., Liu, L., Xian, C., & Wang, X. (2023). A scientometric analysis of payments for ecosystem services research: Mapping global trends and directions. Sustainability, 15(21), 15649.

27. Hwalla, J., Bawab, J., El-Hassan, H., Abu Obaida, F., & El-Maaddawy, T. (2023). Scientometric analysis of global research on the utilization of geopolymer composites in construction applications. Sustainability, 15(14), 11340.

28. Sohail, S. S., Javed, Z., Nadeem, M., Anwer, F., Farhat, F., Hussain, A., ... & Madsen, D. Ø. (2023). Multi-criteria decision making-based waste management: A bibliometric analysis. Heliyon, 9(11).

29. Razzaq, K., & Shah, M. (2025). Advancing cybersecurity through machine learning: A scientometric analysis of global research trends and influential contributions. Journal of Cybersecurity and Privacy, 5(2), 12.

30. Xiao, X., Skitmore, M., Li, H., & Xia, B. (2020). Mapping knowledge in the economic areas of green building using scientometric analysis. Energies, 12(15), 3011.

31. Tian, H., Chen, L., Wu, J., Zheng, D., Yang, Q., Ji, Z., ... & Li, Z. (2023). Global research into the relationship between electronic waste and health over the last 10 years: A scientometric analysis. Frontiers in Public Health, 10, 1069172.