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Reviewing a Decade of Zero Waste Research: Bibliometric Analysis

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Abstract: The purpose of this study is to describe the development of zero waste research over a decade, namely from 2013 and 2022. This study used bibliometric analysis with samples of 413 documents from the Scopus database. The research focuses include: 1) the development of publications and citations; 2) publication status based on influential authors and their countries; 3) dissemination of collaboration among researchers; 4) relevant keywords are used and the pattern of emergence from previous research. The research results show a significant impact in zero waste research studies. Overall, this research serves as a basis for developing new scientific questions that can contribute to the development of further research.

Keywords: Bibliometrics; Environment; Zero waste.

Introduction

Garbage is something that is produced from human or natural activities and is no longer used, not used, and thrown away (Deniz & Bural, 2021; Dutta et al., 2021; Egun, 2009; Kelana et al., 2021). Waste based on the chemical substances contained in it is divided into two types, namely organic waste and inorganic waste (Indrosaptono & Syahbana, 2017; Jones et al., 2022). Organic waste is waste that comes from the remains of living things and easily decomposes naturally (Joustra & Yeh, 2015; Imteaz et al., 2021; Wardani et al., 2021). Meanwhile, inorganic waste is waste generated from non-biological materials, both in the form of synthetic products and the results of the technological processing of mining materials (Kore et al., 2020; Van Bemmel & Parizeau, 2020; Nejati et al., 2015).

Indiscriminate disposal of waste can have a major impact on the environment (Feiziene et al., 2015; Ribić et al., 2017). If disposed of in the open can contaminate the soil (Ngaini et al., 2014; Ribić et al., 2017). Likewise, if it is burned, it will cause air pollution and if it is discharged into the river, it will cause water pollution, clogged drains, and flooding (Huckle, 2008; Nasibulina, 2015). Environmental pollution can hurt human health (Kırlı & Fahrioğlu, 2019; Taşar, 2020; Sakhare et al., 2022).

Many factors cause an increase in waste, including human population growth, lifestyle changes, development, and consumption of non-organic products (Djaelani, 2011; Nousheen et al., 2020; Farzadkia et al., 2021). This is a challenge for waste management around the world. In addition, until now the waste handling by the government has not been optimal (Rapada et al., 2021; Salemdeeb et al., 2022; Ifegbesan et al., 2017). The government has not been able to provide efficient and effective waste management services (Huckle, 2009; Nousheen et al., 2020). This is also exacerbated by the poor infrastructure for waste processing, causing piles of waste (Haq et al., 2020; de Anda et al., 2018). Therefore, a good handler is needed to overcome this problem. One way is to apply the concept of zero waste.

Zero waste is an effort to minimize waste, starting from waste production to the end of production (Neugebauer et al., 2021; Gunti et al., 2018; De Nisi et al., 2021; Baldwin & Dripps, 2012; Diliberto et al., 2020). There have been many studies examining the zero-waste

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concept, but the author is wondering what academic efforts have been made to identify the zero-waste concept in the field and publish it as a whole. In recent years, researchers and practitioners have explored and studied various zero-waste concepts (Nawaz et al., 2021; Hossain et al., 2020; Kuo et al., 2021; De Laurentiis et al., 2018; Wong, 2017; Dileep, 2007). For that, we need a comprehensive discussion related to this topic. Based on the results of the author's search, there has been no research that has analyzed articles using the bibliometric R-package and VOS viewer version 1.6.18 to deeply understand information sharing in the zero-waste research trend.

The purpose of this study is to describe the development of research on the concept of zero waste over a decade, namely from 2013 and 2022. The focus of the research include 1) development of publications and citations; 2) publication status based on influential authors and their countries; 3) dissemination of collaboration among researchers; 4) relevant keywords are used and the pattern of emergence from previous research. Based on the explanation above, the researcher is interested in taking the research title "reviewing a decade of zero waste research: bibliometric analysis".

Method

This study used bibliometric analysis with a sample of 413 documents from the Scopus database. The Scopus database is considered the largest indexing database that is credible and very helpful in the document search process (Aria & Cuccurullo, 2017; Abbas et al., 2022).

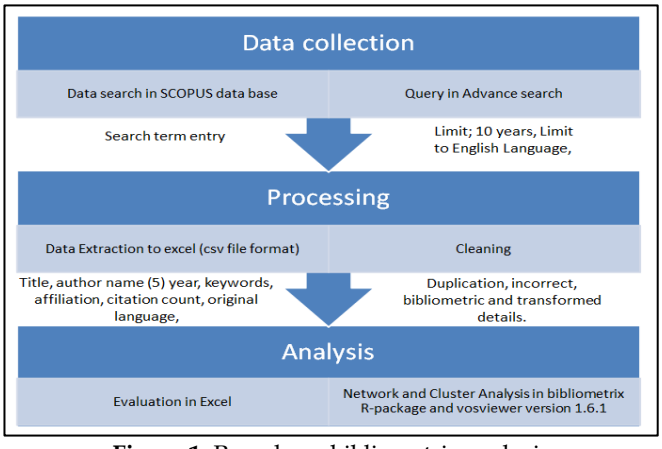

Figure 1. R-package bibliometric analysis

The bibliometric analysis uses performance analysis and knowledge mapping techniques. The process of bibliometric analysis consists of selecting SCOPUS-indexed documents. To facilitate the search process, keywords are used with the search term "zero waste". Several filters are applied to select more relevant articles, such as period range, type of writing, etc.

Bibliometric data analysis using R-package version 4.4.2 and VOS viewer version 1.6.18. This application was chosen because it makes it easier for researchers to visualize the results of research findings in a way that is easy to interpret.

Result and Discussion

Bibliometric descriptive analysis

Table 1. Main Information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2013:2022
Sources (Journals, Books, etc)	140
Documents	413
Annual Growth Rate %	20.58
Document Average Age	2.8
Average citations per doc	27.09
References	23,482
DOCUMENT CONTENTS	
Keywords Plus (ID)	5,027
Author's Keywords (DE)	1,525
AUTHORS	
Authors	1,762
Authors of single-authored docs	18
AUTHORS COLLABORATION	
Single-authored docs	23
Co-Authors per Doc	4.72
International co-authorships %	30.02
DOCUMENT TYPES	
article	413

Based on Table 1, presents information that as many as 413 documents related to zero waste research over the last 10 years (2013-2022 periodic range) were selected and analyzed. These articles appear in 140 publications, most of which are scientific journals. "Keywords plus" is the total number of keywords that often appear in article titles, namely 5027, and the number of authors in this study reached 1762 authors.

Development of publications and citations

Table 2. Annual Scientific Production

Year	Articles
2,013	18
2,014	16
2,015	14
2,016	17
2,017	38
2,018	40
2,019	47
2,020	49
2,021	77
2,022	97

Based on the data obtained, it shows an increase in publications each year on the topic of zero waste (2013-2020), in 2021 there will be a decrease in this topic. One of them is the changing trend of research topics. In 2022 there will be a significant increase compared to the previous year which is the highest increase during this decade with 23.48% (97 out of 413).

Figure 2 shows the average citation development on this topic which is very fluctuates and continues to increase. The average number of citations per year for each publication is approximately 8.13.

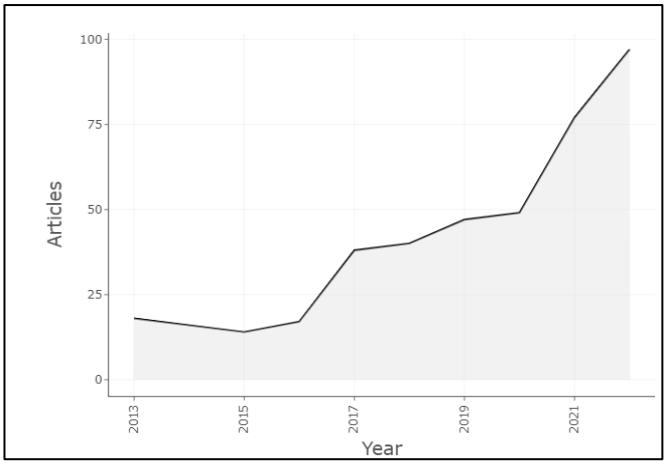

Figure 2. Average Citation Per Year

Publication status by influential author and country

In this discussion, the author will explain the ten most influential and productive writers in the field of zero-waste research from 2013 to 2022.

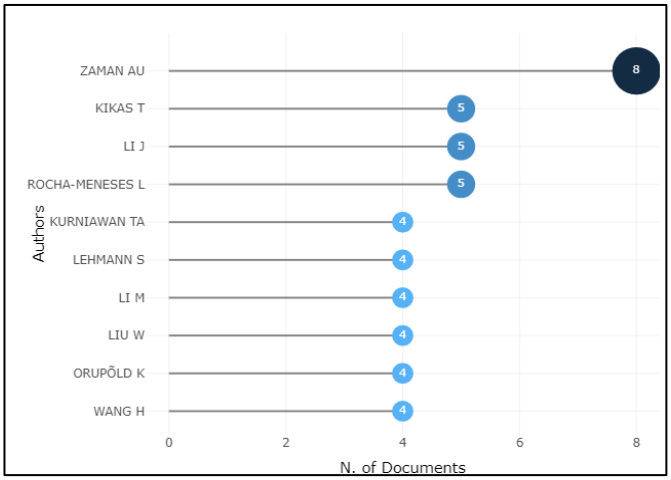

Figure 3. Most Relevant Authors

Moreover, the most influential and prolific authors have consistently contributed to publication over the decade, publishing their research in shorter timeframes.

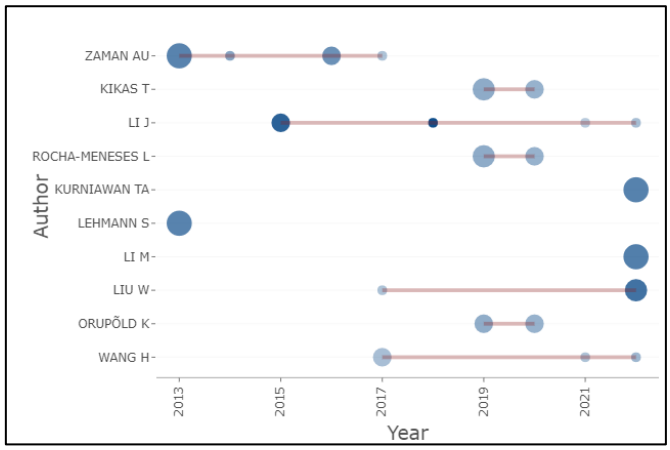

Figure 4. Authors' Production over Time

To see data about countries that conduct research in this field, researchers investigate the author's countries based on the collaboration of many countries or the collaboration of one country. For more details, see the following Figure 5.

Based on the data above, it can be concluded that China ranks first for multi-country collaborations (21 publications) or one-country collaborations (46 publications) with a publication percentage of 16.22% of 413 publications. Followed by India (26 publications), the USA (25 publications), Italy (23 publications), Brazil (16 publications), Poland (16 publications), Spain (16 publications), Australia (15 publications), and the UK (14 publications).

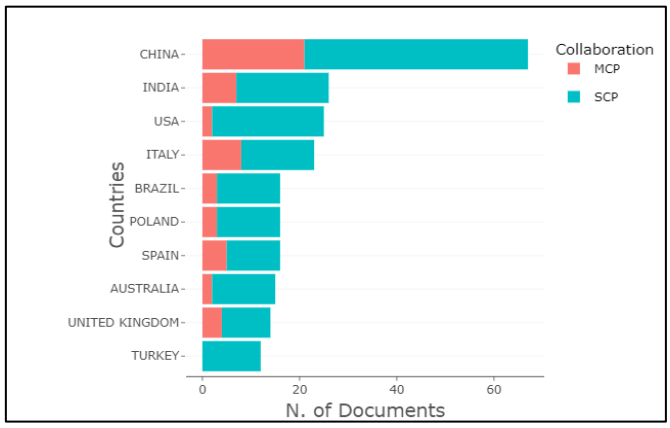

Figure 5. Corresponding Author's Country

Dissemination of collaboration among researchers

Based on the collaboration network between authors, the most dominant in zero waste research are writers from China. The spread of author collaboration between countries is also very diverse. For more details, see the Figure 6.

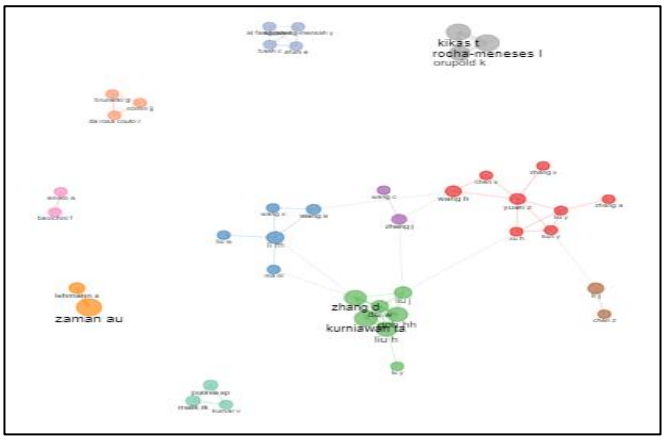

Figure 6. Collaboration Network

Based on collaboration data in various countries, researchers study this phenomenon by highlighting characteristics that have a direct impact on the field. In this research, a collaboration between researchers can manifest itself in a variety of ways, and collaboration is not always associated with co-authored articles. The number of joint publications can serve as a measure of collaboration between researchers. Therefore, researchers analyzed to investigate whether there is extensive collaboration between researchers in zero waste research.

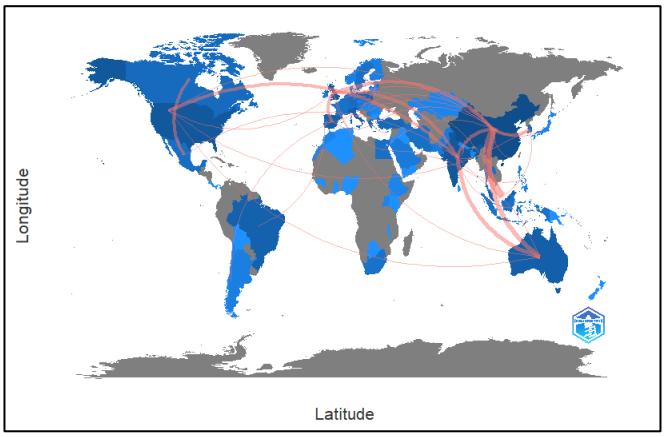

Figure 7. Collaboration WorldMap

Based on the Figure 7, it is clear that the spread of collaboration between countries related to this topic is very wide. The presence of international research networks is shown in blue. Countries with the highest number of publications are countries with a higher level of cooperation than other countries and support each other in developing scientifically useful research results.

Relevant keywords used and patterns of emergence from previous research.

To answer the problem at this point, the researcher used a visualization from the Vosviewer application version 1.6.18.

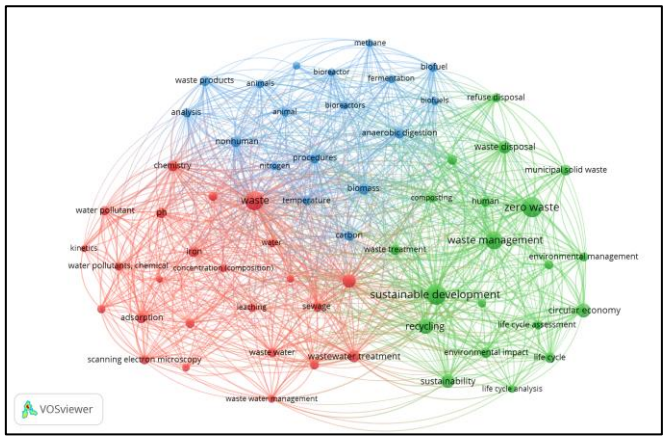

Figure 8. Visualization Keyword Co-Occurrence Patterns

In analyzing keywords there are common terms. For this reason, researchers only take the main topics related to zero waste research. This allows for a more in-depth discussion. A co-occurrence keyword analysis is a technique that examines the actual content of the publication itself. In addition, keyword co-occurrence analysis is based on the assumption that words that frequently occur together have thematic relationships with each other. Analysis of the pattern of occurrence of keywords shows that the most frequently written keywords are zero waste (162 mentions). Other keywords that are often written about are sustainable development (161 names), waste (133 names), waste management (116 names), and recycling (72 names).

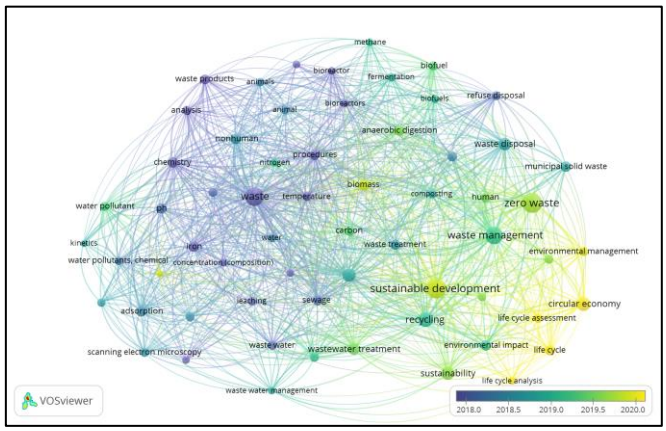

Figure 9. Visualization Overlay from Keyword Co-Occurrence Patterns

The Figure 9 shows the shift in the main focus of research to zero waste. Previous research related to zero waste is in the left cluster and the right cluster is the latest research. Related to this topic, the keywords used are growing and not just fixated on one topic.

In this article, researchers analyze the bibliometrics of the zero waste research field based on 413 articles published within a decade. Researchers use bibliographic data from databases that are tailored to the

specified search. The number of papers published on zero waste research continued to increase during the observation period from 18 articles in 2013 to 97 articles in 2022, with an annual growth rate of around 20.58%. Performance analysis techniques and knowledge mapping were used to answer the four research questions.

Discussion of performance analysis results (research questions 1-3)

The results of research questions 1-3 show that the potential for zero waste research is significantly dominated by authors from China. Among the top ten publication and citation developments, publication status by influential author and country, and widespread collaboration among researchers, eight authors are from China. This is not surprising since China is the second largest spending country in the world in publications and research with a total cost of $400 billion (Tollefson, 2018). China's progress is extraordinary in the field of science and research. This is reinforced by the latest report from the US National Science Foundation (NSF) which shows that China produced the largest number of scientific publications in 2017 and has left other countries such as the United States and the European Union (J.-H. Wang et al., 2022;X. Wang et al., 2022). In addition, China provides compensation for researchers who want to publish their work in reputable journals. China's number of scientific publications has generated at least 15% more articles each year for the last two decades (Mateer et al., 2020; Tian et al., 2016). Based on this description, the researcher believes that the results of these three research questions provide clues for future developments in zero research. China could be one of the countries with research references on this topic.

Discussion of the results of knowledge analysis (research question 4)

The results of research question 4 show that the relevant keywords are used and the pattern of emergence from previous studies related to the most frequently written keywords is zero waste (162 mentions), sustainable development (161 mentions), waste (133 mentions), waste management (116 designations) and recycling (72 designations). If analyzed in depth, these keywords lead to efforts to reduce waste which has an impact on environmental sustainability. Despite the increasing prominence of these concepts, progress in protecting the environment has been slow, and scientists warn that we have begun to pass a tipping point in waste management. (Lewis et al., 2017; Venneman et al., 2022; Modarres et al., 2018; Ilmas et al., 2021). These findings can provide future research directions and can provide an overview for policymakers in considering perspectives and establishing effective strategies toward a better life. (Pauw et al., 2015; Nawaz et al., 2021; Ong et al., 2019).

Conclusion

This research helps analyze the literature on zero waste research presented in the Scopus database. Future research and applications related to zero waste research can be an effort to minimize waste. In addition, zero-waste research plays an important role in environmental issues and climate change. Overall, this research serves as a basis for developing new scientific questions that can contribute to the development of further research.

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Author Contributions

The main author, Jajang Bayu Kelana, contributed to designing research and writing research articles. The second author, Ruli Setiyadi, played a role in conducting research and data collection. The third author, Andi Suhandi in the supervision process and guiding the writing of the article.

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Conflicts of Interest

The authors declare no conflict of interest.

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