

Bibliometric analysis of food waste in economics for Sustainable Development Goals 2030

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Abstract. This research attempts to investigate the economic implication of food waste within the framework of sustainable goals (SDGs) for 2030, using bibliometric analysis. Further, the Scopus database is used in this research; this research analyzes 60 relevant articles covering the period of 1987 to 2024 by using Vos viewer and Publish or Perish (PoP) software to visualize and measure the data. The result of the research shows that the publication trend has fluctuated which has been significantly increasing after 2016, as the campaign of global SDGs is promoted. The key findings show that consumer behavior, economic policy, and social factors play important roles to understanding the food-wasting mechanism. The impactful publications and leading researchers are identified, demonstrating that food waste is related to the economic model; food security; and sustainable implications. This research emphasizes the need to integrate economic strategies with sustainable consumption and production to achieve 2030 SDGs.

1 Introduction

Food is a basic necessity for humans, and everyone needs it to survive. Therefore, food is considered one of the human basic needs that contribute to producing much waste in the environment. Further, some facts related to food waste which are presented in the report of SDGs in 2023 [1] show that although 878 people were affected by hunger; however in 2021 was precisely reported food waste and food loss, which 13.2% of food was lost after harvesting and 17% of food production was wasted in households. On the other hand, in 2019 food service and retail all together produced 931 million tons of food waste [1]. This may indicate that it is essential to give much attention to overcoming the waste food problem to maintain sustainable growth towards 2030 by applying an in-depth analysis of this case.

Wasting food may cause a huge and impactful problem that affects a significant social problem, economy, and environment. Around one-third of food is globally considered to be wasted. This case not only presented a wasteful activity of valuable resources but also led to

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economic losses [2]. The economic implication of food waste is significantly raised in America, where the loss and waste of agri-food lead to the land crisis which needs further investigation [3].

Addressing food waste through the lens of bio-economy and circular-economy models offers a promising pathway to sustainable development by 2030. By integrating the strategy to reduce food waste, this approach effectively promotes income growth and creates jobs as well as supports sustainable local development, which leads to win-win solutions [4]. The potential economic benefits of reducing food waste go beyond direct cost saving, which encompasses broader social impacts such as an increased food security and reduced environmental damage.

Food waste has a valuable impact on the economy which contributes to negative environmental consequences and significant economic costs. This cost includes energy consumption used to produce food that is waste; raw material cost; and wages of food handlers involved in the production and disposal processes [5,6]. Further, reducing food waste has been shown to generate positive economic and welfare effects, particularly in the areas driven by food production; this indicates the real benefits of waste production initiatives [7]. Food waste does not only cause social impact but it also significantly affects any economic challenge. Food wasting, further, has a significant impact on the economy which leads to an increase in hunger crisis, inflation as well as inequality among the population [8,9]. Additionally, there is a big correlation between regional economic prosperity and the household's food waste levels, which gives a fact that the higher gross domestic product is the indicator of higher food waste [10].

Reducing food waste is essential to achieving the goal of creating a sustainable food system. Addressing food waste from an economic perspective; can promote the efficient use of resources reduce the impact it has on the environment and improve food security. Using the Scopus database, this study aims to identify central authors and articles that provide a significant impact on food waste for sustainability development over 37 years. Further, this study aims to show the serious economic consequences related to food waste in the 2030 Sustainable Development Goals (DGs). And finally, the purpose of the research is to identify every aspect that needs further research related to efforts to achieve the 2030 SDGs goals.

2 Methods

Bibliometric research methodology applies the software VOSviewer to analyze and visualize the data. Software Publish and Perish (PoP) is further applied to analyze the citation from the Scopus database using the keyword of "food AND waste OR food AND wasting OR wasting AND food". By using the Scopus database, the resulting paper is 3,222 documents without the exception of publication type, year of publication, or field of publication. Then, the author limited the data by filtering the scope of discussion on food waste in the fields of economics, econometrics, and finance, and only the types of articles used. However, the author did not include the limitation of year publication, which resulted in about 60 articles on the theme of food waste in the field of economics, econometrics, and finance in 37 years (1987-2024). The data is collected from Scopus by exporting the relevant article and including the keyword and abstract of the articles when downloading the data in the format of the RIS (Research Information System) document. The data was then imported in the form of the software Publish or Perish to analyze the citation, including the metric bibliometric calculation such as h-index, g-index as well as the number of citations.

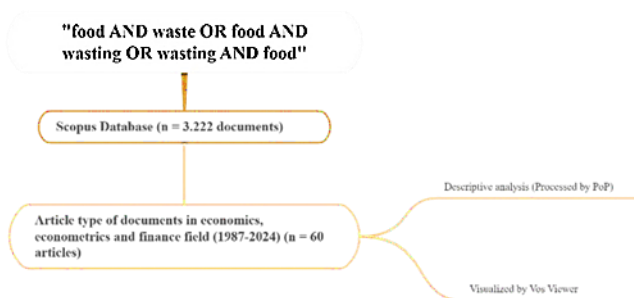


Fig. 1 Research Procedure

3 Result and Discussion

Scopus database is used in searching for articles that will be processed with a publication period of 37 years, that is, from 1987 to 2024. Further, the purpose is more focused on the discussion of food waste and also the type of publication article, the article being analyzed using bibliometric is 60 articles. Figure 2 shows the number of articles in the Scopus database which is collected by using the keyword of food waste.

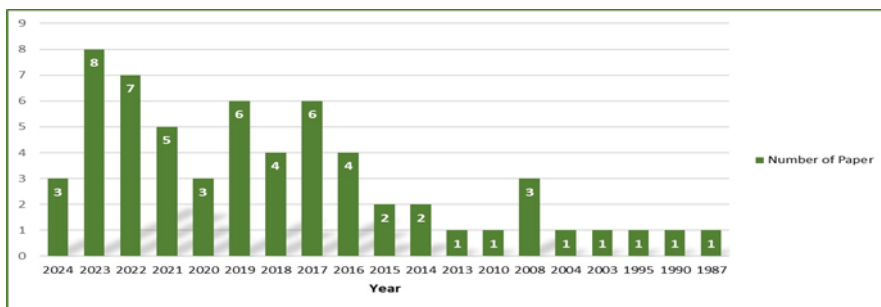


Fig. 2 Number of Paper

Figure 2 shows that the number of food waste research has been fluctuating since 1987. In the Scopus database, scholars were not interested much in the research of food waste in the fields of economics, econometric, and finance every year. It showed that in 1988, 1989, 1991-1994, 1996-2002, 2005-2007, 2009, 2011, and 2012, articles on food waste were not published at all.

In early 2008, there is an increase to the number of article publications on the scope of food waste, around 3 papers. This topic, after however, got less attention because there was only one article on the same topic and scope in 2010 and 2013. Further, from 2019 and 2011 until 2012 there has been no article published. The research trend on the scope of food waste in the fields of economics, econometric, and finance has increased since 2014. Every year, at least two articles are published, and the number of articles being published was significantly raised in 2023 with 8 articles published in the Scopus databased. This trend will be continuously increasing since in the middle of 2024, there has been three publications concerning food waste. In general, the trend between 1987 and 2024 has been showing a significant increase in the number of articles published concern with food waste. This indicates a growth in the awareness of admitting the food waste research as the main research area to support sustainable development.

In September 2015, the members of the United Nations declared local and global commitment in the effort to create prosperity for citizens which encompasses 17 global purposes and goals for the year 2030 [11]. In 2016, there was a significant increase in the publication in food waste. This initials the research done in 2016 titled “Attitude Of Viennese Consumers Regarding The Issue Of Food Waste” [12]. Based on 60 articles which were already published on the Scopus database on the topic of food waste; it showed 158 authors had the same interest in the same research topic. Based on the result of data processed using Vos viewer, it found that 4 researchers consistently have 2 documents on the same topic; they were Eriksson, M; Goddard,E; Liu,G Dan Webb,P [13–20].

Figure 3 comprises the result of the search for co-authorship by including the entire authors, 158 authors. However, the result showed that there were only 12 researchers who were connected and a collaboration that was classified into 2 clusters and were presented by two colors; they were red which was presented for cluster 1, and green which was presented for cluster 2. Table 1 shows the list of the names of the authors on each cluster including the strength relations between the authors.

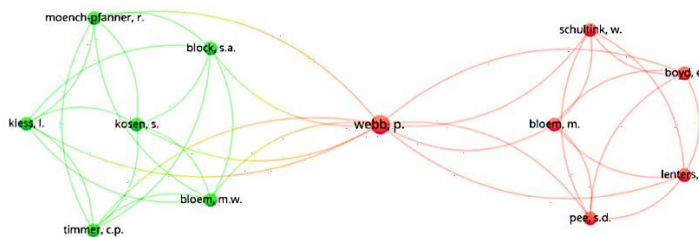


Fig. 3. Co-authorship

The result data processed using Vos Viewer resulted in 2 clusters with a the total link strength is about 36 which is shown in Table 1 [19, 20]. Every link has strength which is presented by the value of positive numeric that shows the strength of relation between the both items. This strength indicates any relation, such as the number of the same reference in a certain publication or the frequency of the collaboration between the researcher [21].

Table 1. Co-authorship Link

Cluster	Author	Link	Cluster	Author	Link
1	bloem, m	5	2	block, s.a	6
1	boyd, e	5	2	bloem, m.w	6
1	linters, l	5	2	kiess, l	6
1	pees, s.d	5	2	kosen, s	6
1	schulthink, w	5	2	moench-pfanner, r	6
1	webb, p	11	2	timmer, c.p	6

Table 1 shows that the researcher that has full impact on the topic of food waste in the field of economics is Webb, P by the relation between researchers is up to 11. Based on the data that has been processed using software publish or perish (PoP), 2 articles published by Webb [20] are “Nutrition in emergencies: Do we know what works?” dan “Macro shocks and micro outcomes: Child nutrition during Indonesia's crisis” [19]. Moreover, in cluster 1,

all authors (Except Webb, P) have a strength link of about 5. This indicates that each of the researchers collaborated with the other 5 researchers on the article they published [19]. On the Table 3, it shows the article most cited by other researcher is “Bringing habits and emotions into food waste behavior”, written by S.V. Russell, et.al. in 2017 by 337 citation, which is 48.14 times citations every year. The research Russel et al [22] is popular and becoming the reference for many researcher who did research on food waste. The result of the study shows that people who were experiencing negative emotion think the food waste more and is intended to reduce food waste; in contrast, they produce more food waste [22].

Table 2. Top 10 most cited paper

Cites	Authors	Year	Cites/Year
337	S.V. Russell, C.W. Young, K.L. Unsworth, C. Robinson	2017	48.14
225	R.O. Babatunde, M. Qaim	2010	16.07
149	K. Scholz, M. Eriksson, I. Strid	2015	16.56
142	S.A. Block, L. Kiess, P. Webb, S. Kosen, R. Moench-Pfanner, M.W. Bloem, C.P. Timmer	2004	7.10
106	B. McCarthy, H.B. Liu	2017	15.14
70	Y. Yu, E.C. Jaenicke	2020	17.50
67	Y. Wu, X. Tian, X. Li, H. Yuan, G. Liu	2019	13.40
64	J. Aschemann-Witzel, A. Giménez, G. Ares	2019	12.80
57	T.J. Richards, S.F. Hamilton	2018	9.50
55	D. Pearson, A. Perera	2018	9.17

Moreover, on the second position is the research of R.O Babatunde, et al. in 2010, titled “Impact of off-farm income on food security and nutrition in Nigeria”. This article has been cited in the last 14 years about 225 times which is about 16,07 times cited every year. R.O Babatunde et al. [23] discussed the income out of agriculture and the effect to the supply chain of qualified food in household, especially for children. The result of the research is related with the food wasting is on the household which has income from agriculture showing the small nutrition that is wasted, if it is compared with the family that did not have income from agriculture [23].

The third most impactful article which was cited about 149 times, titled “Carbon footprint of supermarket food waste”. This article was written by K. Scholz, M. Eriksson, dan I. Strid and was published in 2015 which an average citation is 16,56 times every year. In his article, Scholz [13], said that food waste was becoming a quite big problem and also affected to social costs, the economy, and the environment. In his research, the calculation of the mass and the value of food waste did not impact the environment.

In the fourth position is the article written by the author who most give impact to the topic of food waste, the article titled “Macro shocks and micro-outcomes: Child nutrition during Indonesia's crisis”. This article is written by S.A. Block, L. Kiess, P. Webb, S. Kosen, R. Moench-Pfanner, M.W. Bloem, dan C.P. Timmer in 2004 which already cited about 142 times by the average citation every year is about 7,10 times. This article discussed the survey done by the researcher during the crisis in Indonesia to measure the nutritional impact from Indonesian drought and financial crisis in 1997/1998. The result of their research showed that the decrease of qualified food consumption during crisis raised the possibility of anemia to mothers and children [19].

Table 3. Top 10 Highest Co-occurrence

Keyword	Occurrence	Total link strength	Keyword	Occurrence	Total link strength
food waste	21	143	food security	7	24
article	10	177	child health	6	54
human	10	183	malnutrition	6	75
nutrition	8	66	household	6	58
female	7	154	food	5	40

Table 3 shows the top ten keywords that most emerged in the one article including the total strength of the relation between keywords. The food waste keyword is most the number, that this keyword, of course, is mostly emerged. Further, the total strength of relation by keyword of food waste by another keyword is 143 which weaker than the keyword of human, article and female. To visualize the 117-keyword based on its emergence on at least 2 same documents is showed on the figure 3.

Figure 4 comprises the visualization of data processed using Vos Viewer, that is, Co-occurrence from the keyword. Co-occurrence comprises the condition in which two or more terms (for example the keyword or concept) emerge together in one document or other analysis unit [21]. The result of the data is about 117 keywords which shown in Figure 4, resulting 4 clusters. These 4 clusters symbolized four differences are red, green, blue and yellow. The visualization co-occurrence in VOsViewer showed a strength relation between symbol of the thick of line and the emerge they together in the symbolize of every cluster. Based on the figure 4, it was found that Figure 3, was red which most dominant among other color. This indicates that red is cluster 1. Cluster 1 consists of 44 keywords such adults, article, awareness, awareness campaign, carbon, china, consumer, consumer attitude, consumer behavior, consumption behavior, controlled study, environmental impact, female, food, food storage, food waste, fruit, fruits, habit, household, human, human experiment, major clinical study, male, prediction, dan probability.

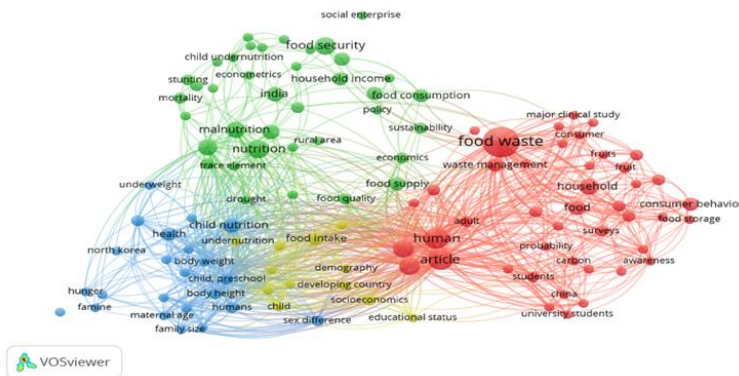


Fig. 4. Co-occurrence

Cluster 1 is includes the dominant keyword that might be shown from the research between 2015 and 2020, by most popular keywords are mostly shown in the year 2020. The keyword of food waste that is most cited was the research of Yang Yu and Edward C. Jaenicke. Their research used the latest approach in estimating the food waste of households, using the model of stocastic limit production which is identified as an input efficiency [24]. Their findings in the research was the behavior of wasting food is found on the pattern of healthier food and the higher income.

Further, the research about food waste and economic behavior is conducted by Krista who researched the influence of promoting, the insight, and subjective norms towards sustainable food-wasting behavior for Z generation in Indonesia [25]. The result is that subjective norms directly affect responsible food waste and support by attitude of Article of S.V. Russell, C.W. Young, K.L. Unsworth, C. Robinson titled Bringing habits and emotions into food waste behavior, which shows the dominant citation that discusses food wasting and behavior, as explained before [22].

Cluster 2 is presented by the green color which shows that 38 keywords was related to each other. The keyword in cluster 2 is agricultural policy, Canada, child anthropometry, child health, child undernutrition, climate change, commercialization, diet, dietary diversity, drought, econometrics, economics, Ethiopia, food consumption, food quality, food security, food supplementation, food supply, health survey, household food waste, household income, income distribution, India, malnutrition, maternal nutrition, micronutrients, mortality, numerical model, nutrition, nutritional requirement, nutritional status, policy, rural area, social enterprise, stunting, sustainability, trace element, dan wasting. Based on the keyword in cluster 2, it clearly shows that the discussion is mostly about food security and social economic impact.

Cluster 2 encompasses any important aspects such as policy for agriculture in countries like Canada, and Ethiopia as well as the impact on children's health, including children's anthropometry, health, and nutrition for children. The Climate change and drought are also a crucial factor that affects food security and sustainability, which focuses on the quality of food, the diet variety, and the safety of the food. The research in this field involves the use of numeric models and econometrics to analyze data from the health survey and income distribution of household. The issue of malnutrition, the lack of micronutrients, and the need of nutrition for mothers as well as children is becoming the main focus, particularly in the rural. And countries like India. The commercial approach and social corporate are also considered to increase the supply chain and reduce food waste in households, by the final purpose is to reduce death rate and stunting as well as increase the level of nutrition and the distribution of income.

Cluster 2 is still the same as the previous cluster which most of the articles were published in the year 2020 and after 2020. One of the articles of T.J. Richards, S.F. Hamilton [26] that researched about the potential of a mutualization system peer-to-peer commercial (CPMS) to exist as market platform to exchange surplus food to support food security and social economy. By reducing food waste, It found the seconder market has the key element that is needed to succeed CPMS; the instrument for a policy that is designed to facilitate transactions in the secondary market could effectively reduce food waste [26]. The visualization of figure 4 shows cluster 3 which is presented by a blue color that has 23 keywords. The keyword of cluster 3 consists of body height, body weight, child development, child nutrition, child preschool, economic aspect, family size, famine, food aid, food insecurity, health, humans, hunger, maternal age, North Korea, preschool child, sex difference, social status, socioeconomic factor, statistical significance, stunting syndrome, underweight, dan wasting syndrome.

Based on the keyword on cluster 3, it is about the theme of all the keywords, that is, "Child Nutrition and Socio-Economic Factors". This theme encompasses any essential aspects concerned with children development during pre-school like the height of the body, the weight, and the nutrition. The issues of leak nutrition like stunting syndrome, underweight, and wasting syndrome are becoming the main attention, particularly, in the context of food security and starvation which are also faced by families in North Korea. Social-economy factors like the number of family members, social status, the difference of gender also affect

the nutrition and the health of children. The research in this field frequently uses statistical analysis to evaluate the relation significantly between those factors and the level of children health status, by the purpose to develop effective policy to increase health and nutrition in any social-economic condition. Cluster 3 is mostly about the researches published in the years before 2010. One of them is the article of S.A. Block, L. Kiess, P. Webb, S. Kosen, R. Moench-Pfanner, M.W. Bloem, C.P. Timmer [19] that explains that in a household mother support for children calory input, that affect less attention to the mother in the crisis of 1997/1998 in Indonesia.

The latest cluster in food waste research is cluster 4 which is presented in yellow color. Cluster 4 consists of 12 words like Bangladesh, body mass, catering service, child, demography, developing countries, educational status, food intake, infant, maternal welfare, socioeconomics, dan undernutrition. From the keyword, the discussion is about the welfare of mothers and children in developing country, including nutrition and food for babies and children. A keyword like demography, education status, and social economic factors describe the greater context of the topic being concerned. The welfare of mothers and children is becoming the main attention, by promoting the care for food and nutrition to increase body mass and prevent lack of nutrition. This research also considers the impact of educational status and economic social to the health and the nutrition of mother and children and also the policy. Cluster 4 shows article which is published on the Scopus database which keywords of food waste in the economic field, econometrics, and finance, which was mostly dominated in 2010. Clusters 3 and 4 have a quite close position if it is seen from Figure 4, that the keyword between two of them has a relation about nutrition for mother and children.

4 Conclusion

Bibliometric analysis of 60 relevant articles documents a considerable rise in research interest and publication trends in this area Exclusively after 2016. The results highlight the need to embed economic solutions together with sustainable consumption and production measures when addressing food waste towards reaching the SDGs. Major lessons from the analysis are that consumer behavior, economic policies, and social biases have substantial roles in identifying food wastage mechanisms. To support the sustainable transformation of food waste management, interventions are required that consider emotional and habitual factors alongside cognitive elements such as subjective norms (experiences or suggestions) and perceived control. In addition, the research helps to outline seminal publications and top researchers in economic studies by illustrating that cross-disciplinary teamwork is required for an all-encompassing policy formation. The study found that the economic gains from reducing food waste are likely so high, including cost savings, increased food security and much less environmental harm. This study implies strong interventions and large-scale social marketing campaigns to obtain better engagement from the consumer side toward sustainability. SDG 12 Responsible consumption and production must enter synergies with a number of other sectors to guarantee an efficient use of resources in the long term.

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