Journal of Namibian Studies, 34 S2(2023): 1774-1788 ISSN: 2197-5523 (online)

Theoretical Framework Review of Plastic Waste Management

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Abstract

Plastic waste management, if managed properly, will produce considerable benefits. An example of plastic waste management can produce wallets, and some can produce clothes. This study investigates the research gap of waste management in the world of computer science, presented in various research articles as qualitative data. This study uses a mixed-method approach to analyze qualitative data using systematic literature review (SLR) and automated content analysis (ACA). There Are five steps, employed in order to explore the research gap : (1) Conducting SLR techniques in data processing with ACA, (2) Facet analysis, (3) Organizing the concepts generated by the analysis facet, (4) Contextualizing the waste management facet, and (5) Establishing a related infocus to form dimension. The result of the study among other : 5 dimensions of plastic waste management including Recycled materials and models, Selection from the trash, The value of recycling, Recycling system, Waste management learning. future studi this to use dimensions to generate Questionnaire to get to collect more data.

Keywords: Systematic Literature Review (SLR), ACA, Waste Management, Facet Analysis, Recycling

Introduction

Waste management issues are of concern to the government and all elements of society. Starting from the dynamics of realizing waste

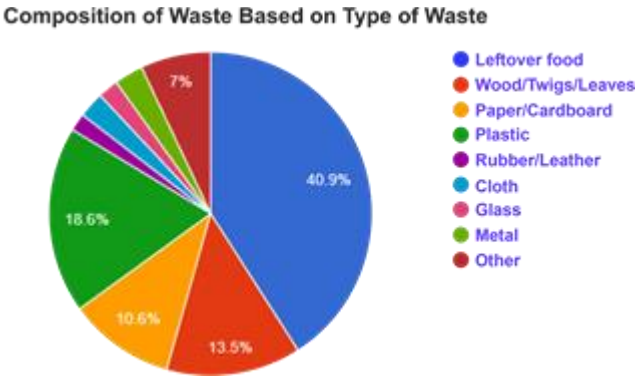
management operations. As we know, the lack of good waste management can have a dangerous impact on the environmental sector, causing disasters such as flooding and the clogging of sanitation channels, which in turn can cause various diseases for the surrounding community [1].

Waste is a serious threat to the sustainability of our economy, society, and environment. So far, many people are lazy about disposing of garbage because of the laziness that arises when disposing of garbage requires opening the lid of a dirty and smelly trash can. In addition, despite the availability of trash bins according to their type, there are still those who dispose of garbage according to its type. Bins that are full must wait until they are picked up by the janitor so that they can be left to pile up. If the increasing pile is not balanced with good processing, various problems will arise. Some types of waste must be disposed of as soon as possible and as far away as possible because they can rot so that they emit unpleasant odors, invite disease seeds, and cause other losses [2].

Municipal waste is initially collected at temporary collection sites (TPS). TPS are divided into different functional areas: 3R (reduce, reuse, recycle), TPS with multi-compartments, and TPS with schedules based on waste type. This division is done before the waste is sent to the landfill. The majority of waste collection activities are still done manually by the formal and informal sectors [3].

Based on its characteristics, most of the collected waste is processed through composting, recycling, gasification, anaerobic digestion, or waste-to-energy systems. However, these approaches have not optimally addressed the economic, social, and environmental aspects of the waste management system. The regulations for waste management are clear and adequate. For example, see Law No. 18/2008 on solid waste management, Government Regulation No. 81/2012 on economically oriented household waste management, and Minister of Environment Regulation No. 13/2012 on waste reduction, reutilization, and recycling through waste banks [4]. According to data on the National Waste Management Information System (SIPSN), in 2022, there will be a waste generation and amount of waste of 19,137,821.53 tons per year. The large amount of waste obtained per year can reduce waste by about 5,013,175.07 tons per year, or about 26%. Waste handling is 9,750,470.55 tons per year, or about 50%; managed waste is around 14,763,645.62 tons per year, and unmanaged waste is around 4,374,175.91 tons per year. From this data, the composition of waste by type is mostly food waste. The following graph of waste composition by type of waste is depicted in Figure 1.

Figure 1: Waste Composition by Waste Type in 2022.



Source: https://sipsn.menlhk.go.id/sipsn/ [14]

Based on Figure 1 regarding the composition of waste based on waste types, the problem of waste or plastic waste is not a simple one, and this problem must be worked on together. We can recycle plastic waste or sell the plastic waste to factories that need it in chopped form. To carry out the waste management that must be applied, you must look at related research that has been conducted before. The problem of waste awareness has two factors, namely the education factor and the employment factor. In the education factor, the belief in the lack of awareness of the waste problem is increasing, and the low level of education extends to the head of the household. While work factors are related to educational factors, control over work and living environments rests with the student.

This research produces a related dimension to create an instrument on the questionnaire, namely building a model regarding waste management. Related research in this study is to predict and compare plastic waste generation rates using non-linear machine learning models, namely an artificial neural network (ANN), a support vector machine (SVM), and a random forest (RF), for the accuracy of predicting plastic waste generation rates using pre-selected socio-economic variables. It is shown that ANN has the best performance. Currently, the recovery of plastic waste generated in the study area is done informally by communities such as scavengers, itinerant waste buyers (IWBs), and scrap traders. On average, scavengers, IWBs, and small and large scrap dealers collect 19, 53, 374, and 650 kg of plastic waste per day, respectively, and earn US$ 1.85, US$ 2.15, US$ 10.39, and US$ 18.07 per day from the sale of recovered plastic waste [6]. In waste management, it is also necessary to have a policy from the local government in the model to optimize municipal waste collection, where the optimized plan is developed in a static context and then integrated into a dynamic context using multi-agent-based modeling and simulation, which creates a Branch Cut algorithm that searches for optimal routes with various garbage trucks on the same route [7]. Other policies also need to be made regarding the use

of reusable plastic bags rather than disposable bags to reduce the volume of plastic waste; source separation is important for effective management and disposal of plastic waste [8]. The current waste management process uses an economic system designed to minimize waste and resource use through recycling or reusing existing materials and products. In a circular economy, materials are taken from the environment, transformed into products, used as best as possible, and then recycled back into the natural environment. This aims to reduce the environmental impact generated by economic activities as well as increase the overall efficiency of resource use [9].

Problems in previous studies that affect the process and reliability of further research where researchers or experts in waste management explicitly create knowledge in various research journals. this study uses a literature review related to waste management conducted by researchers in the form of a related research article.

Simple and common techniques for conducting literature reviews to search for relevant articles In the article searches in this study regarding waste management related to machine learning, waste management related to IOT, and waste management related to artificial intelligence, there are many articles and journals that discuss waste management. For articles related to waste management related to machine learning, waste management related to IOT, and waste management related to artificial intelligence, there are very few articles. Gap analysis is obtained in the discussion of articles obtained regarding waste management as a literature review where an article is obtained that does not meet the context of waste management related to machine learning, waste management related to IOT, or waste management related to artificial intelligence. The literature review technique has a shortcoming in the method of finding relevant articles and limitations in extracting knowledge from available articles.In articles related to systematic literature reviews, statistical data processing only uses certain attributes of the selected articles. Examples of articles that use automated content analysis (ACA) include Digital Technology for Sustainable Waste Management on Board: An Analysis of Best Practices from the Cruise Industry, where this article uses Leximancer to map the main research topics or themes based on visual concepts and manual content analysis [10]. Interpretation of ACA results, particularly those using Leximancer, is limited to a description of the state of the art of a topic or research trend, as shown in [11]. Nevertheless, its potential is enormous. Depending on how to organize the knowledge generated, this collection of concepts can be interpreted from multiple perspectives [12]. Automated content analysis (ACA) using Leximancer can help find gaps in articles related to waste management that have been researched by researchers over the past 10 years.

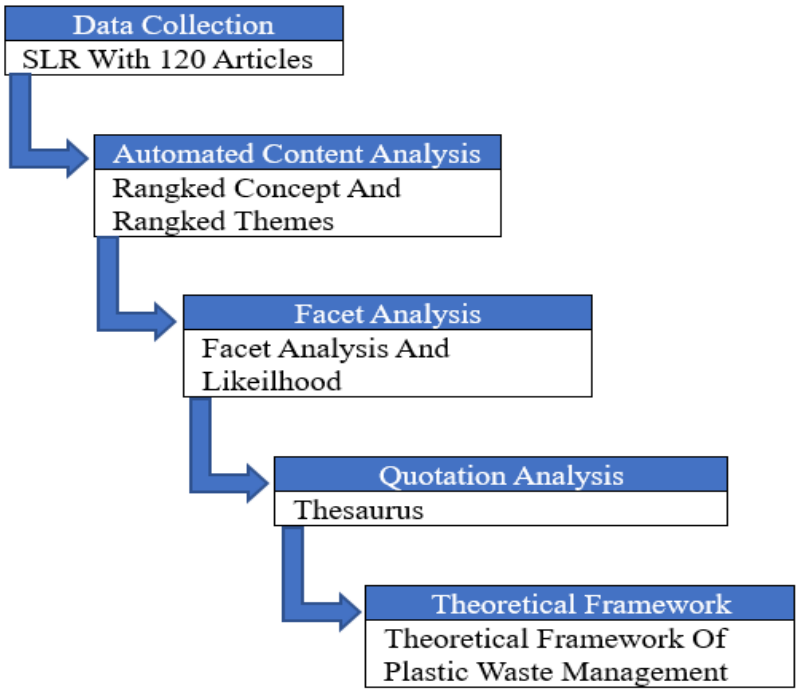
This research analyzes the aspects of waste management, which are then interpreted in various ways depending on the purpose of the research,

which in this study is to build dimensions of waste management, which in turn will be made into a research instrument. So this research examines the research question of how SLR and ACA can be used to develop waste management. To answer this research question, it is organized into several parts. The second part discusses the methods or stages in conducting this research, and the third part applies the stages of the research stages in presenting the implementation of SLR using ACA and producing a dimension to be used as a questionnaire. The last section is a conclusion to the implementation of this research in the form of an SLR presentation.

Method

This research is included in the qualitative category and uses secondary data or public datasets obtained from the SCOPUS portal. The data obtained from the Scopus portal are in the form of articles on waste management, waste management related to machine learning, waste management related to artificial intelligence, waste management related to the Internet of Things, and waste management related to the circular economy, among others. In order for this research to be more focused, a research method is made to solve or answer this research question.

Figure 2. Research method Adapted from ACA



a. Data Collection

Data collection is the process of collecting information that is relevant to the research to be carried out. This data collection process uses the Scopus portal, where we search for articles related to waste management on the portal from articles starting from 2017 to 2023.

b. Automated Content Analysis

Automated Content Analysis is a process of identifying a certain pattern or word or theme in a document and drawing a conclusion about the meaning or meaning of the information in the document. The ACA method can be used with the help of an application called Leximancer.

c. Aspect Analysis

Aspect analysis is a process of troubleshooting a topic or problem that exists in separate components in a document.

d. Quotation Analysis

The quotation technique in Leximancer can help in analyzing and understanding the relationship between concepts in text documents better. It can help researchers discover new patterns and important information that may be hidden in the text document being analyzed.

e. Theoretical Framework

The theoretical framework describes a collection of concepts or dimensions obtained from the results of facet analysis which will be used for further research by generating questionnaires to collect more data.

Result

At this stage, it explains the results of the problem or question in the research. To answer questions and solve these problems by describing one by one each of the stages in the research method. The problem-solving process will be discussed in three parts.

A. Data Collection

The data collection process uses a public dataset where the data is obtained on the Scopus portal in the form of articles. The article was searched with the keywords "waste management", "waste management related to IOT", "machine learning", "artificial intelligence," and others.The article was obtained with as many as 1203 links to the keywords used. The article is at least 7 years old; it starts in 2017 and ends in 2023. After various search processes that have been carried out on these 1203 articles, there are many similarities in the articles taken; therefore, 992 Scopus-recognized articles were obtained. The purpose of this data collection is to understand trends. Data can be used to identify trends and patterns, thus helping us understand how a phenomenon

changes over time and explore the knowledge base of waste management.

B. Automated Content Analysis

The content analysis uses the ACA method. Where Leximancer helps the ACA process by importing data, generating concept seeds, generating a thesaurus, and visualizing the results. The process starts with importing pre-selected articles. Then, the tool parses the terms from all the articles, weighting them based on frequency and likelihood of occurrence. These weighting scores become the basis for sorting terms, eliminating low-scoring terms, and assigning high-scoring terms as resulting concepts [5].

The ACA analysis method process required only 120 Scopus reputable articles with predetermined keywords. Before visualizing the ACA analysis process, one must understand a concept or seed keyword. The concept or seed keyword is the starting point of the definition of the concept or keyword. This process then adds highly related terms to the definition of the concept or keyword. Thus, if there are more relevant terms than the seed, a new concept seed or keyword can be generated. This process continues until all terms have been processed. Concepts or keywords that are highly related to each other will be grouped into higher data representations, called themes [5]. Figure 3 illustrates the themes or topics that are interrelated. To determine the theme or topic of related topics by using applications that support ACA analysis, to display themes or topics related topics by using 120 articles.

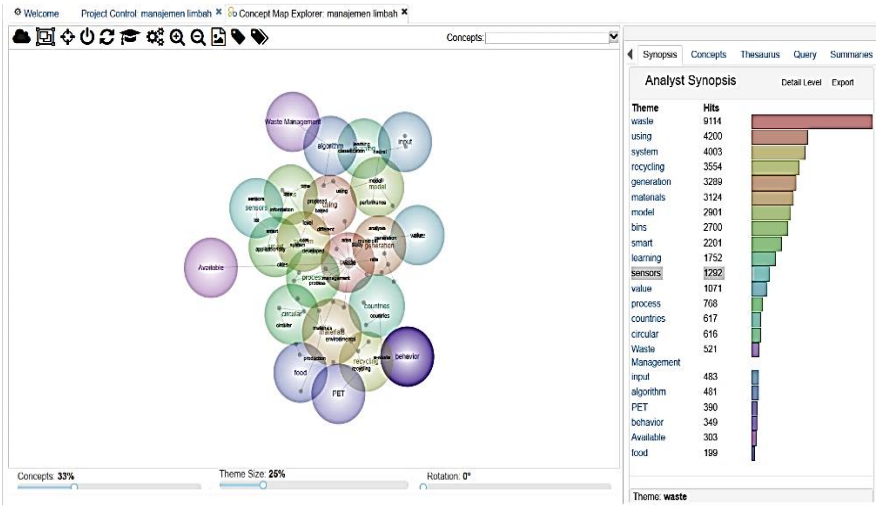
Figure 3. Topic Guide

The next step is to visualize topics or themes based on the number of hits using an application that supports the ACA method, the visualization process with the application can be seen in Figure 4. Shows an illustration of relevant terms regarding waste management. The theme or topic that appears as a candidate dimension.

C. Aspect Analysis

An application to perform analysis using the ACA method is a text analysis software that can be used to identify and map aspects in the text, which can assist users in understanding the patterns and relationships among the concepts or keywords. aspect analysis using applications that support the ACA method can help identify certain aspects in the text, such as topics, themes, or emerging sentiments. The application can be used to identify relationships between these aspects, such as correlation, interconnectedness, or disconnectedness. The application will also visualize topics or themes by sequentially offering the largest hits to the smallest hits, as shown in Figure 4. The figure illustrates the concepts or keywords generated with a relevant term den meaningful. A topic that appears as a candidate dimension in related works, the topic will change according to the topic size setting. Setting the theme is done carefully by 25% where considering the number of hit numbers that appear will affect the shape of the bar chart and there will also be differences in the upper and lower cuts seen in Figure 5.

Figure 4. Topics or themes in applications that support the ACA method



According to Luhn's theory, word lists arranged according to the method outlined will generally be in the form of a diagram, as in Figure 5. The presence in the highest frequency region of many words or topics that were previously described generally has a significant type that is searched for, namely the word "waste" in the system [13]. From Luhn's theory, it can be explained that an arrangement of this topic or theme explains the condition where the condition of the word that is at the top is the word that is general. Words that are at the lower limit are less relevant words, and words that are at the upper and lower limits are assumed to be the most relevant words.

Figure 5. Topics in the Upper and Lower Cut

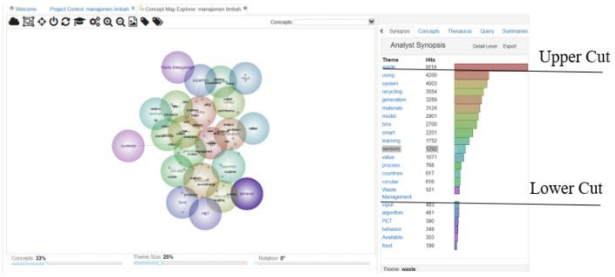
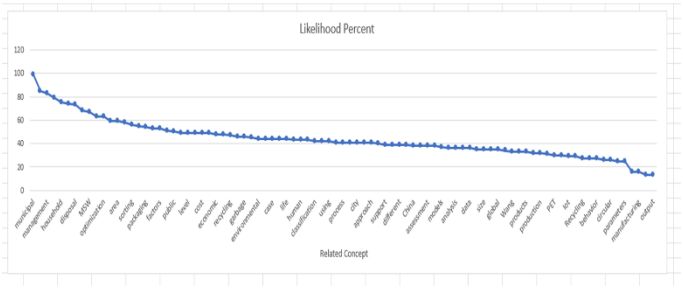


Figure 6. Graph of selecting relevant topics



Likelihood can identify a concept in a text document; the more frequently a text or a concept appears, the more likely it is that the word or concept is important in the context of the analysis being carried out. In Figure 6, choose this relevant topic using Luhn's theory, where the lower limit explains when the curve starts to flatten while the upper limit explains when the curve starts to decrease but not too sharply [13]. This concept was chosen by having the number located between the top and bottom pieces. The concepts in the graph consist of the left side indicating the number of occurrences of each topic or theme, and the bottom side of the graph mentioning the words that often appear from certain concepts in a document.

D. Quotation Analysis

An analysis of this quote is to contextualize aspects of waste management or a knowledge of an insight that underlies aspects of waste management in a given context. To determine various aspects of understanding a topic or theme by using facet analysis. Citation analysis aims to assist in better analyzing and understanding the relationships between concepts in text documents or where the topic occurs. This process looks for citations that contain that aspect, which includes a combination of concepts.

Each facet can contain more than one facet and depth of knowledge.This facet analysis uses a thesaurus related to waste management that is searched through Leximancer. A thesaurus is a dictionary or list of words used to group words and phrases that have similar meanings or are semantically related. The purpose of using a thesaurus is to assist

researchers or users in finding words that are relevant to the topic being searched and to enrich the vocabulary of words used in a particular language. Figure 6 shows that a word in a concept or topic is carried out using the thesaurus technique. The concept (Keyword) or topic used is waste management, where the concept or topic is checked by thesaurus with the words "available", Recycling" and "PET". To perform the thesaurus technique, you can use the facilities provided by MS. Word or can enter the link https://www.thesaurus.com/

Figure 6. Concepts in the topic using a thesaurus

Available	Recycling	PET
• inconvenient • limited • occopied • unvailable • unobtainable	• Improvement • Recovery • Redemption • Repossession	• Common • disfavored • hated

Quotation analysis can also use the existing features in Leximancer, namely the Insight Dashboard. The Insights Dashboard on Leximancer is used to make it easier to identify patterns and trends in text data and use this information to make better decisions. To use the insight dashboard, enter words as categories and later combine them with words as attributes; the search process uses the "AND" operator. The category entered is "waste management" and the attributes used are "algorithm", "sorting", "neural", "recycling", "system", "application", "IOT" and "circular". Table 1 shows the ranking of concepts for categories, which shows the level of strength, rail frequency, and superiority in selecting categories by combining an attribute. In this process, the topic of waste management with algorithms is one that is often used in research, while the topic of waste management with circulars is one that is less interesting.

Table 1. Concept or keyword ranking for categories

Category: waste management

Concept	Rel Freq (%)	Strength (%)	Prominence
algorithm	3	2	2.1
sorting	2	1	1.2
neural	2	1	0.9
recycling	7	1	0.9
system	5	1	0.8
application	2	1	0.7
iot	1	< 1	0.6
circular	1	< 1	0.5

After doing the concept or keyword ranking of categories, the technique of Concept or Keyword Ranked Compounds for Categories can be done where the operator used still uses "AND". In the concept or keywords of ranked compounds for this category using 1 category by comparing 2 attributes, including the category "waste management" with "application" "and" "IOT", "waste management" with "sorting" "and" "recycling", "waste management" with "system" "and" "IOT", "waste management" with "system' "and" "application", "waste management" with "recycling" "and" "circular" and the last is "waste management" with "recycling" "and" "circular". Table 2 shows the concept or keyword of Ranked Compound for Categories which shows the level of strength, rail frequency and superiority in the selection of categories by combining an attribute. In this process where the topic or word waste management with application and IOT becomes a word or topic that is often widely used in research, while the topic of waste management with recycling and system becomes a topic that is less attractive.

Table 2. Concept of Compounds Ranked by category.

Category: waste management

Concept	Rel Freq (%)	Strength (%)	Prominence
application & iot	< 1	2	12.6
sorting & recycling	< 1	2	5.1
system & iot	< 1	1	4.4
system & application	< 1	< 1	1.6
recycling & circular	< 1	< 1	1.6
recycling & system	< 1	< 1	0.4

E. Theoretical Framework

A theoretical framework is a collection of interrelated concepts with the purpose of helping to organize a research or study. Theoretical frameworks have several sources to draw from, including existing theories and research findings. A theoretical framework can also be developed specifically for a research project, based on a synthesis of existing knowledge and insights from experts in the field. The theoretical framework for this study can be seen in Figure 7.

In Figure 7 explains the Theoretical Framework for Plastic Waste Management where it starts from the recycling system which is a process of collecting and returning used materials that will become materials that can be reused. the purpose of this recycling is to reduce the amount of waste that exists.

After the recycling system, it will continue into waste selection, where waste selection here is a process of sorting waste to separate different types of waste so that it can be processed in a more effective way. in waste selection there are several ways including: manual selection,

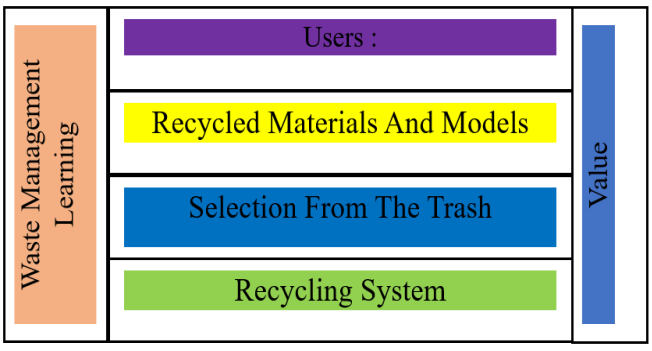
mechanical selection, optical selection and chemical selection. from the selection process aims to reduce the amount of waste volume that will be disposed of in landfills.

After the waste selection system will continue into a process of recycling materials and models, where recycling materials and models can help improve environmental and economic sustainability and reduce negative impacts on the environment. examples in recycling materials and models: Paper, Plastic, Metal, Glass and Textile.

The next stage in this theoretical framework is the user, where the user or User is needed to carry out the process as well as the sustainability strategy in the waste management process. users include collectors, scavengers, local governments, regional governments to the central government. the user of collectors and scavengers is a user who carries out the recycling process in waste management. while the local government, regional government to the central government as a future policy design that must be taken in processing waste management in plastic waste recycling.

in the 4 pillars or 4 stages, everything will be connected to a waste management learning. in waste management learning is a learning process in carrying out effective waste management. there are several aspects in waste management learning including: introduction to types of waste, how to manage waste, knowledge of the impact of waste and waste processing technology. from a waste management system correctly, it gets a value for all circles. for example, the value obtained for the local government will be a healthier environment because the area has carried out waste management and not only that, there will be a significant decrease in the amount of waste to be disposed of and an increase in the amount of waste that has been recycled.

Figure 7. Theoretical Framework Of Plastic Waste Management.



Conclusions

This research was conducted as a systematic literature review (SLR), using approximately 120 articles related to waste management. The keywords

in the search for articles obtained in reputable journals consist of waste management related to IOT, waste management related to machine learning, waste management related to artificial intelligence, plastic waste management, and others. In the process of searching with these keywords, it was found that there were not too many articles or journals that discussed waste management related to machine learning or artificial intelligence, but many articles discussed waste management only in terms of the environment, health, and others. After searching for articles related to these keywords, an automated content analysis (ACA) process is carried out using the lexical content analysis (ACA) process, where ACA visualizes a topic or theme that is often studied by researchers. The ACA process helps to get a gap analysis, which will be researched next, and ACA can also show how much one topic or theme combines with other themes in the presentation results. This research produces dimensions that are used to create questionnaires, which are obtained from facet analysis using a thesaurus. A thesaurus is a dictionary or word list used to group words and phrases that have the same meaning or are semantically related. The purpose of using a thesaurus is to assist researchers or users in finding words that are relevant to the topic being searched. The results obtained in the facet analysis were "available" "recycling", and "PET", From the 3 topics or themes in the facet analysis, 5 aspects were obtained in the Theoretical Framework, including recycling materials and models, bin selection, recycling value, recycling systems, and waste management learning.

Bibliography

1. Sa'diyah, A.F., Purnomo, E.P. and Kasiwi, A.N. (2020) 'Waste Management in the Implementation of Smart City in Bogor City', Jurnal Ilmu Pemerintahan Widya Praja, 46(1), pp. 271–279. doi:10.33701/jipwp.v46i1.773.
2. Fatmawati, K., Sabna, E. and Irawan, Y. (2020) 'Rancang Bangun Tempat Sampah Pintar Menggunakan Sensor Jarak Berbasis Mikrokontroler Arduino', Riau Journal Of Computer Science, 6(2), pp. 124–134.
3. Kannan, D. et al. (2020) 'Sustainable circular supplier selection: A novel hybrid approach', Science of the Total Environment, 722, p. 137936. doi:10.1016/j.scitotenv.2020.137936.
4. Fatimah, Y.A. et al. (2020) 'Industry 4.0 based sustainable circular economy approach for smart waste management system to achieve sustainable development goals: A case study of Indonesia', Journal of Cleaner Production, 269, p. 122263. doi:10.1016/j.jclepro.2020.122263.
5. Rahman, Amalia. Et al. (2022) 'Critical Review of Technology-Enhanced Learning using Automatic Content Analysis',(IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 13, No. 1, 2022, P. 386-394.

6. Atul Kumar, S.R. Samadder , Nitin Kumar, Chandrakant Singh. (2018). 'Estimation of the generation rate of different types of plastic wastes and possible revenue recovery from informal recycling'. Waste Management 79 (2018) 781–790.
7. Khanh Nguyen-Trong, Anh Nguyen-Thi-Ngoc, Doanh Nguyen-Ngoc, Van Dinh-Thi-Hai. (2016). 'Optimization of municipal solid waste transportation by integrating GIS analysis, equation-based, and agent-based model'. Waste Management, Doi : 10.1016/j.wasman.2016.10.048.
8. Ohidul Alama, Mukaddis Billah , Ding Yajie. (2018). 'Characteristics of plastic bags and their potential environmental hazards'. Resources, Conservation & Recycling 132 (2018) 121–129.
9. Antonia Gravagnuolo, Mariarosaria Angrisano and Luigi Fusco Girard. (2019).'Circular Economy Strategies in Eight Historic Port Cities: Criteria and Indicators Towards a Circular City Assessment Framework'. Sustainability 2019, 11, 3512; doi:10.3390/su11133512.
10. Vaio AD, Hassan R, D'Amore G, Strologo AD. Digital Technologies for Sustainable Waste Management On-Board Ships: An Analysis of Best Practices From the Cruise Industry. IEEE Trans Eng Manage 2022:1-14.
11. B. Hyndman dan S. Pill, "Apa yang ada di dalam sebuah konsep? Analisis penambangan teks Leximancer tentang literasi fisika di seluruh literatur internasional," European Physical Education Review, vol. 24, no. 3, hal. 292-313, Agustus 2018, doi: 10.1177/1356336X17690312.
12. X. Lin, H. Zhang, H. W u, dan D. Cui, "M enerapkan pengembangan pengetahuan dan area perbatasan dalam penelitian tata kelola risiko publik," International Journal of Disaster Risk Reduction, vol. 43, hal. 101365, Februari 2020, doi: 10.1016/j.ijdrr.2019.101365.
13. H. P. Luhn, "Pembuatan Abstrak Literatur Secara Otomatis," IB M Journal of Research and Development, vol. 2, no. 2, hal. 159-165, Apr. 1958, doi: 10.1147/rd.22.0159.
14. SIPSN - Sistem Informasi Pengelolaan Sampah Nasional [Internet]. [cited 2023 Feb 13]. Available from:https://sipsn.menlhk.go.id/sipsn/