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A MODIFIED DSM BASED ON SOCIAL MEDIA FOR TREATING WASTE MANAGEMENT ISSUE

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Abstract. *Social media is a suitable medium for most researchers to perform analysis on, including the waste management. In Indonesia, waste is a very common issue especially when it comes to landfills, pollution, loitering, and floods. This research is focused on finding out and rating the quality of Indonesia's waste management activity from several views, and highlighting the specific issues that caused the problem. The K-Means clustering, fuzzy logic, and mathematical model were operated to decide the final quality of the waste management and Twitter was used as the social media source for this research. While the research provided the decision support model (DSM) which produces the concrete results. The final quality value of 56.02 means that the quality of Indonesia's waste management quality is lacking in several aspects. Also, the result of study proposed several decisions which should be practically taken to solve the problem.*
Keywords: Indonesia, Decision support model, Text mining, Fuzzy logic, Twitter, Social media, Waste management

1. **Introduction.** Social media (SM) is a very common online platform being reasonably benefitted to communicate around the world. It has become integrated into the lives of millions of people, as in around 2.46 billion worldwide in 2017 [1], although it has been explored as a potential teaching tool only recently [2]. Even so, it is a very relevant thing to multinational firms, medium sized agencies, nonprofit organizations, and governments alike [3]. By exploring it, we are also able to gain information that is valuable to support decision making that can bring benefits to individuals and companies equally [4]. With an abundance of functions and activities, analyzing anything related to people's lives and needs is not something uncommon these days, especially with social medias that are aimed to express own ideas (e.g., Instagram/IG, Twitter, and Facebook).

On the other hand, the waste management issue has been one of the common public topics around the world, particularly with the condition of environment nowadays. [5] mentioned that waste management is something that needs more public awareness and engagement in order to be able to develop a sustainable system for that field. Researches related to waste management had been done in various ways. [6] proposed a new method to help Regina, a city in Canada, in selecting a new landfill site. [7] conducted a case study about how a solid waste bank is needed to respond to the waste management challenges in the City of Padang, Indonesia, up to the year of 2028. [8] analyzed the available Internet of Things devices in various cities in terms of managing waste collection.

With the great quantity of SM users as mentioned previously, the quick spread of information that happens from one location to another, in multi directional manner, [9] means that one big change can happen to many aspects, when it is talked often within a certain period. It can improve the innovation level of newcomers in making start-up businesses [10], providing real-time updates such as disasters, either man made or natural

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[11], especially in a nation that is not the most advanced in such feature [12], and ensuring companies' transparencies via feedback and employee engagements [13]. For a platform that is so often used by scholars [14], analyzing environmental related issues like waste management is an obvious possibility. Public involvement can also provide more views about the actual situation that can be communicated across different instances, resulting in more public support towards the matter [15].

Based on aforementioned description regarding utilization of SM, we identified that people's opinions about everything that can be talked can be a very useful material to conduct sentiment analysis on and eventually produce something that can benefit the public needs in the future. Similarly the waste management in Indonesia is a reflection on how good or bad the waste management in the nation is. Rants and discontent from users would reflect on negative aspects of the waste management and vice versa. This is a very good indication that sentiment analysis should also be performed on this topic to gain more insights on one of the environmental issue aspects in the world.

In different way to obtain the Twitter data, we proposed K-Means clustering algorithm as the way to determine the parameters that will be benefitted as the basis criteria of measuring the waste management quality, while keep utilizing the fuzzy logic as the decision support model (DSM) method after sufficient data are gathered via both the SM and online questionnaire. In the previous work of [16], with the same case, the study managed to determine five parameters and conclude the research with two parameters with positive value and three parameters with negative value, which means there should be improvements being made in that specific waste management field, and also generated the value of 56.90 for the overall quality. The potential is there to expand the determinators of waste management quality and using clustering algorithm as a way to find more parameters that can help go even deeper in terms of finding the steps needed to be taken to improve Indonesia's waste management quality.

In this research, the SM utilized is Twitter. The aim is to highlight waste management issues in Indonesia using public tweets with specific keywords. The extraction of the data was completed using a browser plugin called Web Scraper [17]. The proposed social media DSM based on fuzzy logic and K-Means clustering conceptions is novel scientifically. Then also, the suggestion of the best decision alternative to solve waste management issue in Indonesia produced by such a proposed model is practically fruitful. All study results are delivered in this paper with organization consisting of introduction, related works, research methodology, result and discussion, and also conclusion and further works.

2. **Related Works.**

This research is derived from the previous research being done by [16], where [16] developed a DSM based on SM by collecting data via free SM analyzer and analyzing parameters manually. The improvements offered here are in the different methods of collecting data, revising parameters being used in the model, and using additional method in parameterizing the data. Similar research with a different case was also conducted with Venn diagram as one of the methods [18], ending with highlighting one important parameter that decides the important part in the corruption case. Various researches involving DSM as main research topic have been done in the past. [19] constructed a DSM method to support group decision making problems, focusing on the consistency improvements. Eventually the research managed to utilize an optimal model for consistency high level. [20] utilized fuzzy preference programming, fuzzy technique for order of preference by similarity to ideal solution (FTOPSIS), and aggregation method to create DSM to fix supply chain management problem. [21] used artificial neural network (ANN) as one aspect in their DSM for evaluating the quality of sewage treated in a septic tank and a vertical flow filter.

There are various cases that can be done for SM analysis. [22] used Facebook and Twitter to conduct study on a pizza service in US. The research was able to eventually recommend the company and others in utilizing SM as a powerful tool for strategic marketing. [23] analyzed early impact of research literature using Twitter data. The research utilized SentiStrength for prediction tool and Altmetric.com for the data source. [24] analyzed the IG comments towards singer, Miley Cyrus to determine the fans' perception towards her, and involves cleaning the text out of unnecessary words. The results found out that there are more negative comments compared to the positive ones on Miley's official account. [25] used SM analysis in dissemination urological information and also highlighted the crucial components of Twitter (e.g., retweets and viral posts). [26] proposed Polaris, a system for analyzing and predicting users' sentimental trajectories during events attracting huge SM attention, with Twitter as one of its data source during the research, and was able to score a good result despite the large room for improvement by adding the number of training data. Most of these researches used the platform to gain and highlight important data for analysis and eventually determine the parameters for detailed explorations. All of these did not cover the waste management field yet. Because of the huge potential of this field to be explored via sentiment analysis, it is a very high potential field to be explored since public also mention this issue a lot.

3. **Research Methodology.** This research consists of five simple study stages (Figure 1) starting from literature studying until model testing. Firstly, literature study is performed so knowledge about the next steps can be obtained. Once that has been accomplished, the next step is mining the data of Twitter texts posted by public users during the year of 2019 except December using a free web scrapper browser plugin. The tweet language used during this research was Bahasa (Indonesian language), and the terms that become the keywords of the Twitter mining are "Sampah", "Manajamen", "Polusi", and "Lingkungan". Once the scraping is done the next step is text processing. Since the text data are in Bahasa, the preprocessing uses the Python Sastrawi plugin. The techniques used in this step are tokenizing, stemming, case folding, stop-words removal and punctuation removal.

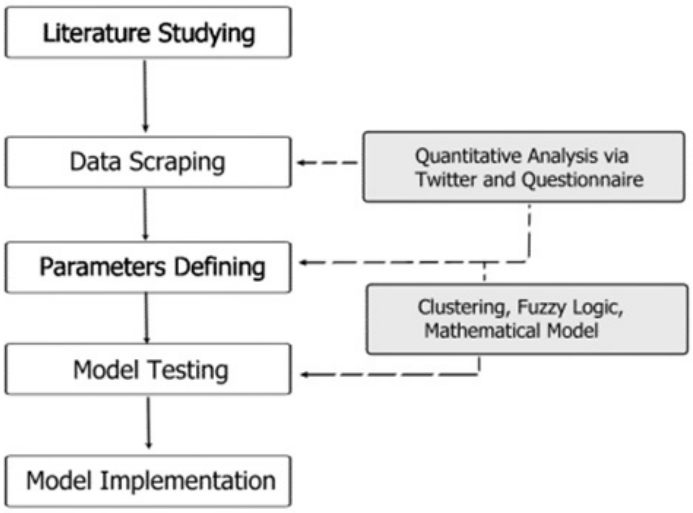

FIGURE 1. The steps of the research

The next step is parameters defining. To do so, K-Means clustering is used to form groups of similar texts [27]. Up to 18 attempts were conducted to generate from 5 up to 10 clusters and 3-7 different words as the centroids inside. Further analysis as well as the literature review of [16] resulted in total of 7 parameters in total. Five of them are derived

from the previously mentioned work and the remaining 2 are added as new parameters in this research. The parameters are "Environmental Awareness", "Public's Knowledge", "Law Enforcement", "Opportunity", "Public Facility", "Spirit" and "Leadership".

"Environmental Awareness" describes the awareness of Indonesia's citizens regarding waste. "Public's Knowledge" is about people's knowledge about the waste, ranging from its impact until the economic value once the waste is recycled into something else. "Law Enforcement" touches on how the government enforces rules and regulations regarding waste management. "Opportunity" touches on the questions regarding the conversion of waste into something with economic values, such as recycled tools and materials. "Public Facility" symbolized optimally functioning infrastructures that are available in relation to the waste management activities. "Spirit" presents the citizens' willingness to contribute in improving the waste management program and environmental management act, such as persuading others to not liter, dividing between organic and non-organic waste when dumping them. Finally, "Leadership" is about how are the acts of citizens and leaders alike can influence others to do the same. The "Law Enforcement" parameter is the biggest coefficient of all 7 parameters with the value of 0.37 (Table 1), where the coefficients actually determined via deep analysis of number of parameter texts' appearance in clusters built by K-Means clustering.

Table 1. The parameters used

No.	Parameter	Sources	Coefficient
1	Law Enforcement (LE)	[29,30]	0.37
2	Environmental Awareness (EA)	[31,32]	0.24
3	Spirit (SP)	[33]	0.17
4	Public's Knowledge (PK)	[34]	0.11
5	Opportunity (OP)	[35]	0.06
6	Public Facility (PF)	[36,37]	0.03
7	Leadership (LD)	[38]	0.02

Once the parameters are defined the next step is to acquire the data based on the parameters via questionnaires. The questionnaire contains 7 questions, one representing each parameter. The samples of this questionnaires are the citizens of Indonesia in general. After the questionnaire data is acquired, the next step is constructing the DSM and implementing it to the existing data. Several methods used are fuzzy logic which is used to eliminate parameters' biases [28] (ever also operated by [39]) and mathematical models to present the relations between parameters and assist to make the eventual decisions.

4. **Results and Discussion.** The Twitter scrapping was done smoothly using the Mozilla Firefox browser and the text data obtained contained so many unneeded words such as "yg" and "dsb", which is not registered in Sastrawi's stop-words database, which means we had to manually add the list of the stop-words. There is also tweets containing links and pictures which means further cleansing was required. A total of 362 tweets were extracted between January 1st 2019 and December 2nd 2019. The questionnaire gathered 453 responses in the span of 7 days. The crisp input (CI) values, which are average values with a range of 1 to 5 extracted from each parameter's questions can be viewed in Table 2.

Furthermore, Figure 2 shows the steps of the proposed model. Scraping tweets and text cleansing are the first steps followed by the gathering of data via questionnaire. The data would then be processed in the next steps. Figure 3 presents the class diagram that represents the high level configuration of the constructed model. The diagram shows that classes "Citizen", "Waste", "Facility" and "Government" will be helping the decision making process along with the fuzzy logic model.

TABLE 2. Parameter's crisp input and fuzzy values

No.	Parameter	Crisp input	Fuzzy value
1	PK	4.64	0.36H 0.64VH
2	EA	4.13	0.81H 0.19VH
3	LD	3.52	0.52M 0.48H
4	SP	3.42	0.58M 0.42H
5	PF	3.22	0.22M 0.78H
6	OP	2.10	0.9L 0.1M
7	LE	1.13	0.87VL 0.13L

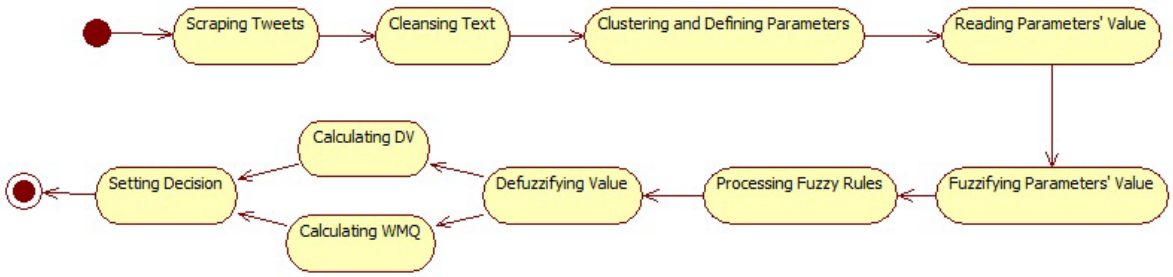

FIGURE 2. The proposed model algorithm

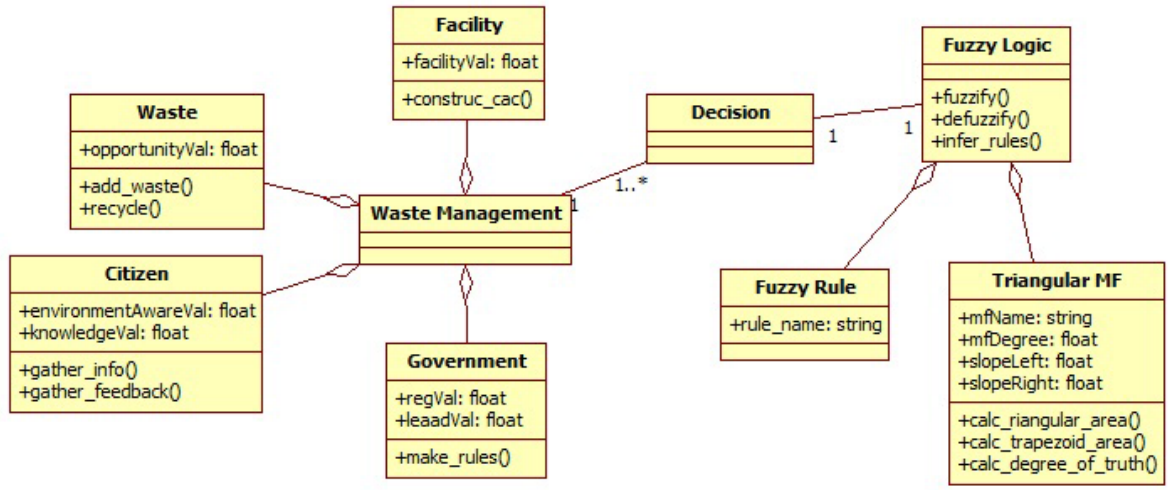

FIGURE 3. Class diagram of the proposed model

There are two values that are going to be the determinator of Indonesia's waste management quality. The values are the decision value (DV) of each parameter, and the final waste management quality (WMQ). Figure 3 shows how to get these values. Firstly, each parameter will undergo fuzzification, processing using rules, and defuzzification process, before serving as inputs for WMQ (Equation (1)) and DV (Equation (2)) calculations. Each generated DV is going to determine the specific actions needed to be taken in each parameter whilst the WMQ value serves as the overall score of Indonesia's waste management quality.

$$\dot{W}MQ = 0.24EA + 0.11PK + 0.06OP + 0.03PF + 0.17SP + 0.02LD \tag{1}$$

$$\dot{D}V_{def} = \frac{\sum_{i=1}^{n} DV_i CE_i}{\sum_{i=1}^{n} DV_i} \tag{2}$$

Each parameter's CI score values will be divided to five steps of values: very low (VL), low (L), medium (M), high (H), and very high (VH). These values will be converted into significance values, which consists of classes: bad (B), middle (Mi), and good (G). Each conversion process is done using fuzzy rules. Significance values from each parameter will be converted into the final DV also using fuzzy rule. The DV consists of two classes: improved (IM) and maintained (MA). The DV should qualify for one of these two classes. "Maintained" means that the quality of the said parameter is good enough and "Improved" means that extra efforts needed to be done by government and people to improve the waste management quality in terms of that category. Then, Figures 4, 5 and 6 represent the range of each parameter's fuzzy triangular membership for parameter's CI, significance values, and DV respectively, containing classes mentioned previously.

Tables 3 and 4 meanwhile represent the significance and decision values resulted from the fuzzy logic process, and also showed the membership value of each parameter. The WMQ is determined by Equation (1), by summing the multiplication between each parameter's coefficient and crisp input value. DV is determined by Equation (2), where DV_i is the ith decision value and CE_i is the ith centroid.

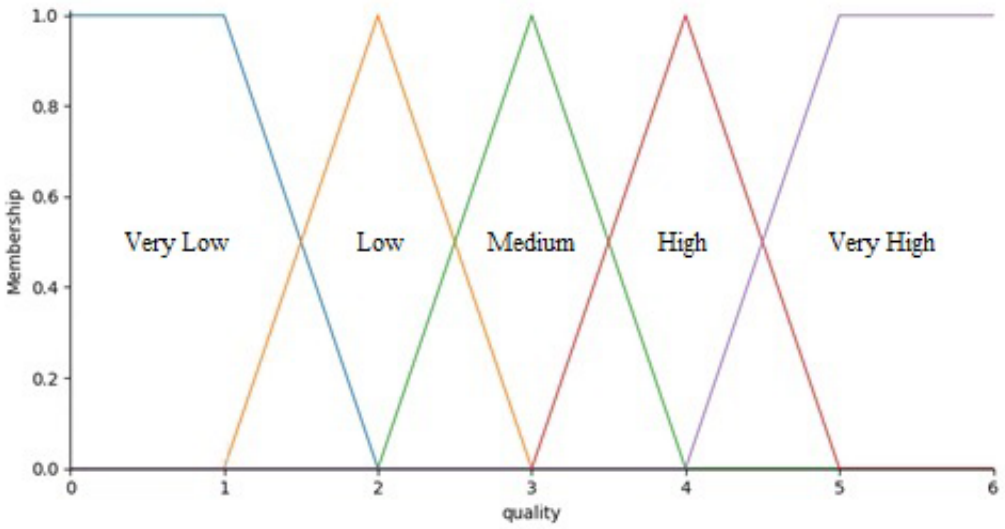

FIGURE 4. Fuzzy triangular membership for parameter crisp input values

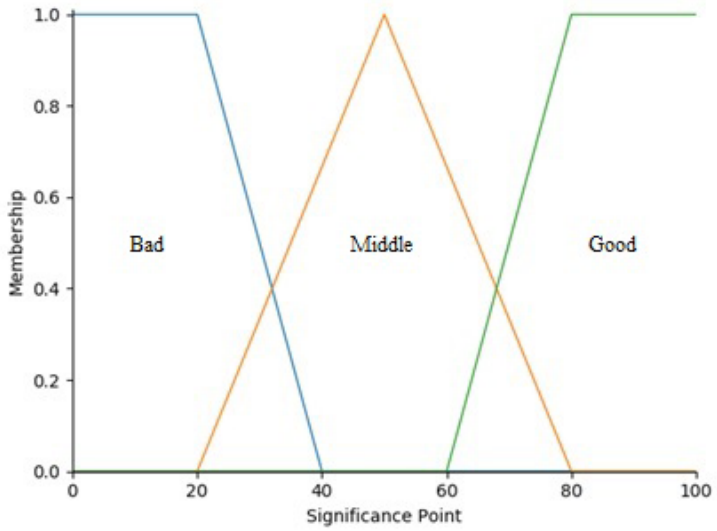

FIGURE 5. Fuzzy triangular membership for significance point values

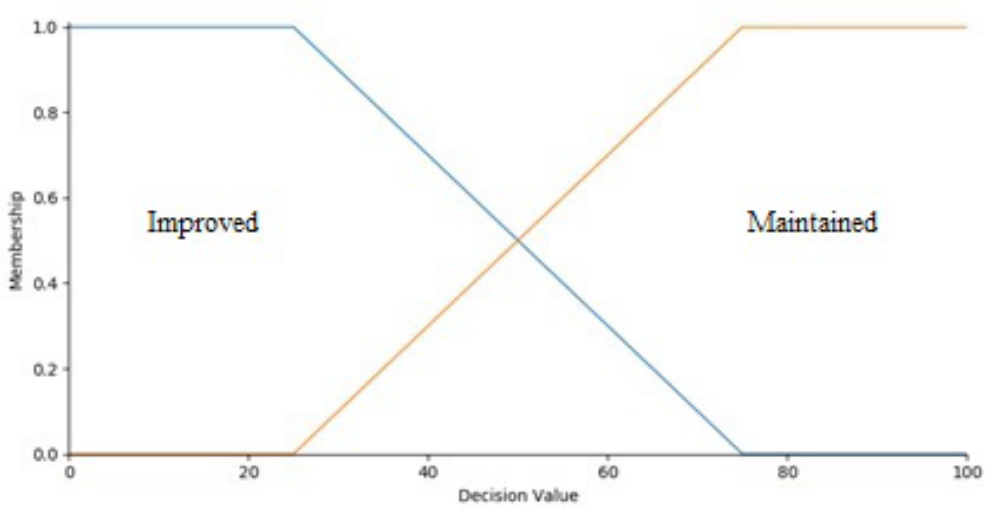

FIGURE 6. Fuzzy triangular membership for decision values

TABLE 3. Parameter's significance and fuzzy values

No.	Parameter	Significance	Fuzzy value
1	EA	84	1.00G
2	PK	83	1.00G
3	LD	64	0.50M 0.20G
4	SP	61	0.63M
5	PF	56	0.80M
6	OP	21	0.98B 0.03M
7	LE	16	1.00B

TABLE 4. Parameter's final decision values

No.	Parameter	Decision value	Fuzzy value
1	EA	73	0.04IM 0.96MA
2	PK	73	0.04IM 0.96MA
3	LD	41	0.68IM 0.32MA
4	SP	33	0.84IM 0.16MA
5	PF	29	0.92IM 0.08MA
6	OP	28	0.94IM 0.08MA
7	LE	27	0.96IM 0.04MA

Tables 5, 6 and 7 contain the parameters for CI, significance values, and final DV. Each table shows the range of each class during the phase and the points where the membership value is "1". The columns "Range Min" and "Range Max" indicate the range of the membership while "Peak" is the range of the values where the class membership values will be exactly "1".

The final WMQ value generated by the constructed model was 56.02. This result is 0.88 lower compared to the previous research, meaning even more significant progress needed to be done to control the waste management policy and increasing the awareness of the citizens. For the fact that out of 7 parameters only two of them are positive compared to the previous research with the same number of "Maintained" parameters out of 5, this could be a factor in determining the declining value. Of all parameters gathered only two of them showed positive results, being "Environmental Awareness" and "Public's Knowledge". This shows while the public is aware of the waste management issue, there

TABLE 5. Parameter's crisp input classes

Class	Range Min	Peak	Range Max
Very low	0	0-1	2
Low	1	2	3
Medium	2	3	4
High	3	4	5
Very high	4	5	...

TABLE 6. Parameter's significance value classes

Class	Range Min	Peak	Range Max
Bad	0	0-40	2
Middle	20	50	80
Good	60	80-100	100

TABLE 7. Parameter's significance value classes

Class	Range Min	Peak	Range Max
Improved	0	0-25	75
Maintained	25	75-100	100

are so many things that could be improved in terms of the implementations, from law enforcement, recycling and public's spirit to put the garbage in the proper category. Table 8 shows the decision proposed based on each parameter's final DV. For "Environmental Awareness" and "Public's Knowledge", all needs to be done is to simply increase the awareness towards the environment and education of the proper waste management habits. For other categories the actions listed below should be done as soon as possible.

TABLE 8. Proposed decisions based on final decision values

No.	Parameter	Decision acts
1	EA	Increasing implementation of good waste management habits
2	PK	Continuing public lecturing and awareness message
3	LE	Improving lawmakers' quality
4	OP	Cooperating among related institutions, marketing
5	PF	Improving waste management and recycling technology
6	SP	Marketing
7	LD	Improving waste management stewarding, acknowledging and promoting role models

5. **Conclusion and Further Works.** The improved DSM strengthened the previous research by utilizing more parameters in determining Indonesia's waste management activities. With the final WMQ value of 56.02, this looks like a setback compared to the previous research; however, it also serves as a reflection of how much progress needed to be made to improve Indonesia's WMQ, especially when there are only 2 satisfactory aspects, in "Public's Knowledge" and "Environmental Awareness".

Further study topics are possible to do, such as a different algorithm used to find the right parameters as the indicators of the WMQ and broader sources operation of SM data. With conducting the next study, it becomes clearer to the public in Indonesia about how much of an importance good waste management habits.

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