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Using K-Means Algorithm to Investigate Community Behavior in Treating Waste toward Smart City

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***Abstract*— Urban communities' behavior in disposing and managing waste around the house is still very concerning. This study aims to analyze and classify community behavior patterns related to waste disposal to help the Makassar City Government overcome waste problems. The methods and techniques applied are using the Waterfall model and the K-Means Algorithm. The stages of analysis and classification of behavior patterns can assist city governments in making strategic decisions. The variables determined include education, age, occupation, free time, smoking status, and questionnaire (outreach, law, knowledge, and facilities). The K-Means algorithm calculation results are 39 people in cluster 1 and 10 people in cluster 2. In cluster 1, it is known that the community tends to take care of the environment in the sub-district where the community lives. Cluster 2 has a low average yield, such as people who do not know the impact laws, inadequate sanitation facilities, and lack of proper waste management towards smart city governance. Based on testing for each method, the Cyclomatic Complexity value generated is four. Therefore, it can be concluded that the white box testing on the K-Means algorithm runs well because each test produces the same value. The government and the community have a responsibility to carry out waste management properly, make use of goods and refill facilities, know the legal impact of littering and follow the socialization held by the Makassar City Government.**

***Keywords*— Algorithm; behavior; urban communities; waste management; smart city.**

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I. INTRODUCTION

The waste problem in Makassar City has not been resolved. The high population density makes high public consumption. On the other hand, the land to accommodate the remaining consumption is minimal, so that the problem increases. Waste that many urban residents consume is not easily decomposed like plastic waste. The increase in plastic waste causes severe pollution. Some people have realized this condition through growing efforts to reduce plastic waste. It can be done by replacing other types of waste that do not damage the environment. The waste treatment plant is essential because it positively impacts much more than a negative impact [1].

Waste is a problem that must be dealt with and managed not to cause other impacts that can endanger the surrounding community's environment. Influencing factors are the increasing population and the handling of waste in Makassar, which has not been optimal. Community behavior in managing waste household gives a role in leading generates greenhouse gas emissions, such as action carry out activities burning trash and littering [2].

From a biological standpoint, behavior is an activity of the organization concerned, which can be observed directly or indirectly. Human behavior is the human activity itself [3]. Three components affect human behavior: cognitive, affective, and conative components [4].

The waste problem includes 3 (three) parts, namely the downstream, process, and upstream. On downstream, continuous waste disposal increased. On the part of the process, limited resources are both from the community and government. In the upstream part, it is less the optimal system applied to final processing [5]. Waste processing involves using facilities and infrastructure, among others, placing trash on containers that are already available, the collection process waste, transfer, transportation waste, and waste processing up to the final disposal process [6].

A relevant factor concerning waste management's health effects is how much and which population is involved in such risks. Unlike what happens for urban ambient air pollution, exposure to pollution from waste management facilities does not include all the residents of an urban area, but only a small part of the population living in the vicinity of the plants [7]. Planning for effective waste treatment will result in the waste

processing system being less than optimal. In addition, there is no place to process waste into an underlying problem [8].

The cognitive component is an intellectual aspect that is related to the humans understanding. The affective component is an emotional aspect. The conative component is the volitional aspect related to habits and willingness to act [9]. Human behavior cannot be separated from the individual's state and the environment in which the individual is located. Behavior is the activities of someone visible or invisible. This means that individual behavior can affect the individual itself; besides that, the behavior also affects the environment. Likewise, the environment can affect individuals [10]. Learning from the case of the death of sperm whales stranded in the waters of Wakatobi, Southeast Sulawesi, the government and the community need to learn from these events. What is truly concerning is that in the belly of the 9.6-meter-long whale was found plastic waste weighing 5.9 kilograms [11].

The waste problem is the result of community behavior. It can be understood together that the source of waste comes from nature, which provides and results from the community's remaining needs [12]. Lack of public awareness of waste can cause various problems such as pollution of odor, soil or water. In general, only a small amount of waste is collected and disposed of properly, so waste handling is very bad and is expected to worsen [13]. Waste can cause environmental disturbances, so that it needs special handling. The Makassar City Government faces challenges and obstacles in handling waste, so it tries to create a clean and pleasant environment.

The existence of Law No. 18 of 2008 [14] and Regional Regulation No. 4 of 2011 concerning waste management has been able to assist the Makassar government in governance towards smart cities [15]. Solid waste can be an opportunity and potentially negatively impacted if it is managed inappropriately [16]. Efforts are made to reduce problems in the waste environment by analyzing people's behavior in disposing of waste in a day, whether people throw waste in the trash or litter. The research aims to analyze and classify people's behavior patterns in disposing of waste to help the Makassar City Government create programs that deal with waste. The research results are expected to help the government improve waste management to live an orderly, peaceful and healthy life.

The development of waste management has been able to provide broad opportunities for the government and society. Membrane technologies, such as microfiltration, ultrafiltration, nanofiltration, and reverse osmosis, have been studied to treat textile wastewater and recycle water in the textile industry [17]. Waste management provides a solution for urban life. It requires waste management in supporting smart cities, which require a variety of technology services that are useful for the lives of city people. It is possible to make smart cities by promoting innovative solutions. Using Information and Communication Technology (ICT) to collect and analyze large amounts of data generated by several sources, such as sensor networks, wearable devices, and IoT devices spread among the city [18].

Classification is the process of guided learning (supervised learning). Classification is used to predict classes of objects whose classes are not yet known [19]. Clustering is used for grouping data based on similarity in data objects and vice versa, minimizing similarity to other clusters [20]. Integrating the clustering method with classification results from the model has better accuracy than the classification method. The study produced an application that classifies community behavior patterns in disposing of waste to provide solutions for the Makassar Environment Agency.

II. Material and Method

A. Waterfall Method

The waterfall method is a model developed for software development or designing software. The model develops systematically from one stage to another in the waterfall model [21]. This model consists of 5 interrelated and related stages:

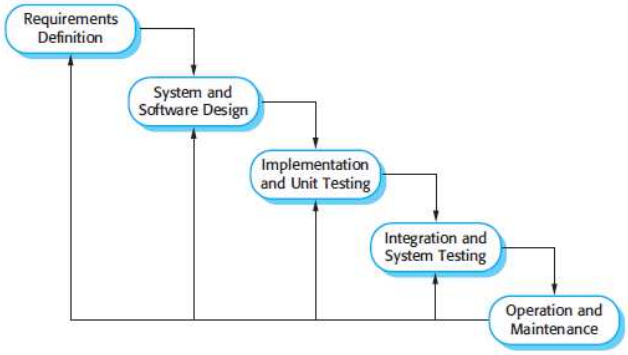

Fig. 1 Waterfall Model

The waterfall model states that work should move to another phase only when the previous phase is reviewed and verified. The various modified waterfall models may include minor variations in this process. These variations include returning to the previous cycle after defects were found downstream or returning to the design phase if the downstream phase was deemed insufficient. Waterfall Model stages, namely:

1) Requirement's analysis and definition. The system's services, constraints, and goals are established by consultation with system users. They are then defined in detail and serve as a system specification.

2) System and software design. The systems design process allocates the requirements to either hardware or software systems by establishing an overall system architecture. Software design involves identifying and describing the fundamental software system abstractions and their relationships.

3) Implementation and unit testing. During this stage, the software design is realized as a set of programs or program units. Unit testing involves verifying that each unit meets its specification.

4) Integration and system testing. The individual program units or programs are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer.

5) Operation and maintenance. Normally (although not necessarily), this is the longest life cycle phase. The system is

installed and put into practical use. Maintenance involves correcting errors that were not discovered in earlier stages of the life cycle, improving system units' implementation and enhancing the system's services as new requirements are discovered.

B. Classification Performance

This is a work to evaluate data objects in a particular class from some available classes. In the classification, there are two processes carried out. Building a model to be stored as memory and using the model to make an introduction or classification or prediction of other data is known in which class the data object is entered based on the model stored in memory. Classification performance measurement is done by confusion matrix, which is a recording table of the work of classification [22], as follows:

TABLE I
CONFUSION MATRIX FOR THE CLASSIFICATION OF TWO CLASSES

f_{ij}		Class Prediction Results (j)	
		Class = 1	Class = 2
Original Class (i)	Class = 1	f_{11}	f_{12}
	Class = 2	f_{21}	f_{22}

Each f_{ij} cell in the matrix states the number of records or data from class i whose prediction results enter class j. From the confusion matrix, we can know the amount of mapping data predicted correctly by adding up the values of f_{11} and f_{22} ($f_{11} + f_{22}$) and the amount of mapping data predicted wrong by adding up the values of f_{21} and f_{12} ($f_{21} + f_{12}$). The accuracy of the predicted results can be calculated when the amount of data that is classified correctly or incorrectly is known. To calculate the accuracy, using the formula:

$$Accuracy = \frac{Amount\ of\ data\ predicted\ correctly}{Number\ of\ predictions\ made} \quad (1)$$

C. Clustering

It is a process of grouping data into several clusters or groups so that data in one cluster has a maximum level of similarity and data between clusters has a minimum similarity. Clustering divides data sets into groups where the similarity within a group is greater than between groups [23].

D. K-Means

K-Means is a non-hierarchical data clustering method that attempts to partition existing data into one or more cluster forms. The purpose of data clustering is to minimize the objective functions set in the clustering process, which generally try to minimize variations within a cluster and maximize variation between clusters.

Data clustering using the K-Means method is done by a basic algorithm [24], that is:

- Determine the number of clusters.
- Allocate data into clusters randomly.
- Calculate the centroid or average of the data in each cluster.
- Allocate each data to the closest centroid/average.
- Return to number 3 (three) if there is still data that moves the cluster or if the centroid value changes.

K-Means has the advantages and characteristics which are required for management. Characteristics of K-Means:

- K-Means is very fast in the clustering process.
- K-Means is very sensitive to the initial random generation of centroids.
- Allows a cluster has no members.
- The results of clustering with K-Means are unique (changeable).

III. RESULT AND DISCUSSION

A. Requirement Analysis and Definition

Analysis of community behavior was done by observing and interviewing 5 (five) samples from 14 districts, namely: Mariso, Mamajang, Panakukang, Rapoccini, and Tamalate in the center of Makassar. The interview was conducted with the Environmental Service on Urip Sumoharjo street number 8 on August 28, 2018, with the Head of Subdivision of Waste Management Policy and B3 Waste Compilation, regarding community behavior that affects the problem of waste in the city of Makassar.

The following are the results of the interview:

- The government has tried to disseminate to the public to be disciplined, responsive, and aware of waste.
- Not available facilities that support activities in dealing with waste.
- Public awareness of the mutual assistance program is still low.
- The environment agency is expected to have a system of coordination between service and sub-district.

The results of the interview with a Lecturer in Psychology at Atma Jaya Makassar University, namely:

- Patterns of human behavior are formed because of internal factors. These are formed due to heredity, physical health, and the brain, while externally formed from the social environment's encouragement.
- There is no specific method in determining questionnaire questions. Social questions can support decisions about people's behavior patterns.

The interview is conducted with Mariso sub-district residents who live on Jalan Haji Andi Mappanyukki. The community claimed that they still did not clearly know the government program and information on cleaning services managed by the sub-district. According to the residents, there is no clear information about the schedule for picking up rubbish so often rubbish looks piled up and causing a bad smell. Some residents litter because they do not care about the environment.

B. System and Software Design

1) Context Diagram and Tiered Diagram: There are 4 (four) entities consisting of departments, sub-districts, communities, and psychologists connected in the Information System. There are four main processes in the system: data verification, interaction processes, data clustering, and reports. The data verification process is divided into sub-district and community data input, and the reporting process is divided into community and waste status.

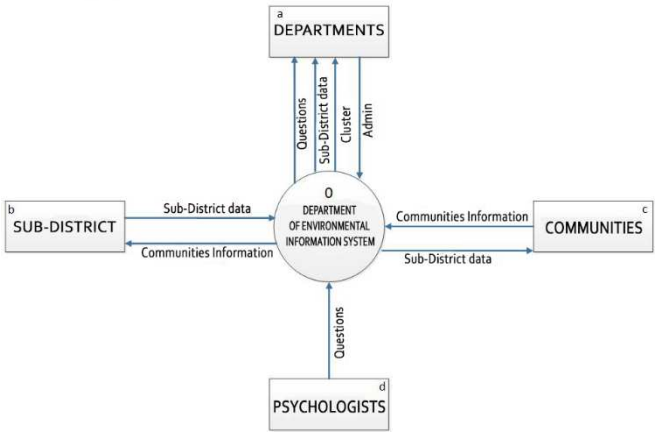

Fig. 2 Context Diagram

A context diagram is a diagram that can describe how a data documentation process is. The context diagram consists of a circle of the transformation process, data sources, and data destinations receiving or sending data directly from the transformation process.

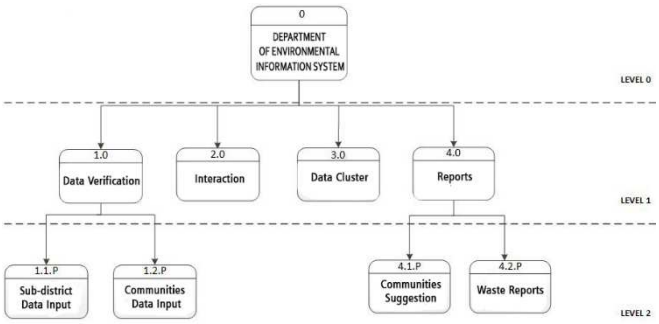

Fig. 3 Tiered Diagram

2) DFD Level and EER: Data Flow Diagrams illustrate four main processes in the system: Data Verification, Interaction, Data Clustering, and Reports connected to each other. The level diagram has data storage, namely biodata, suggestion, sub-district, waste report, questionnaire, object, and cluster. To form an integrated system, a database is needed in the form of diagrams. The EER image consists of 13 tables with the names of biodata, waste-data, questions, suggestions, data, sub-district, admin, questionnaire, object, cluster, factor, center-cluster, and centroid. The data flow diagram illustrates the data verification process divided into two sub-district data inputs and community suggestions. The community data itself contains the community's biodata in a sub-district and suggestions regarding services and facilities available in residence, and sub-district data consists of sub-district areas in Makassar City. The number of waste transport facilities available, both small and large vehicles, can handle the volume of waste around the community. The reporting process is divided into 2 (two), namely community suggestions and waste reports. Community suggestions are in the form of reports containing biodata of people in a sub-district and suggestions regarding services and facilities available in the area where they live.

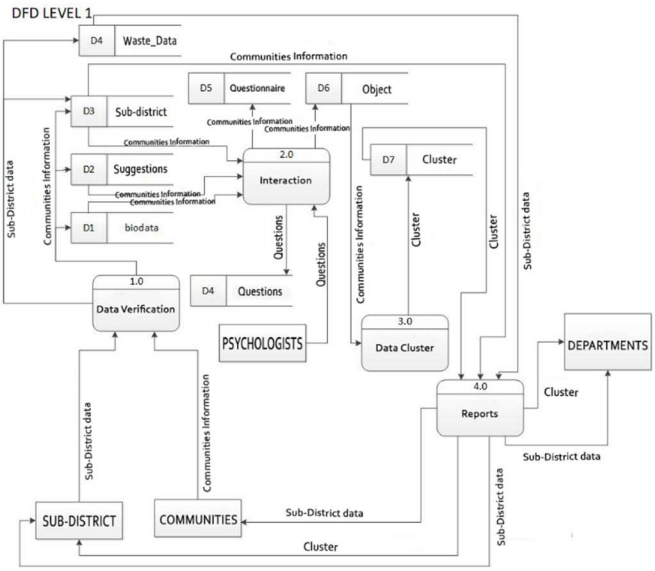

Fig. 4 DFD Level

Building a database on a system will require interconnected tables. Data Flow Diagrams (DFD) is a diagram that uses symbols to describe the flow of system data, whose use is very helpful for understanding the system logically, structured, and clear. DFD is designed to show a system divided into smaller sub-systems and underline data flow between these two things. DFD are modeling tools that allow system professionals to describe the system as a network of functional processes that are connected to one another by data flows, either manually or computerized.

3) Program Menu, System Diagram, and Flowchart: The program menu consists of Home, Community Form, and Information (Community, Trash, Schedule, and TPS). In Figure 5, the system design can be seen the process of the system to be made first determine the criteria that will be input. The input is used in the next process, which is the calculation of K-Means. After the clustering calculation process is complete, there are 2 (two) outputs or results: cluster 1 and cluster 2. The program flowchart starts with the community entering data themselves, filling out questionnaires, and suggestions. Data that has been entered into the system will then be tested using the K-Means Algorithm. Data that has been entered is then tested with data in the form of a number of attributes that have been given weights; then, the results are in the form of entities. The entity's final result will be sought by the central cluster value to produce 2 clusters, which are community factors in disposing of waste. It starts with entering community data, questionnaires, and suggestions, algorithmic processes, displaying the results of calculations and storing them in the K-Means database. The system diagram consists of the criteria for internal and external factors. These factors are grouped and classified using K-Means' calculations resulting in 2 (two) different clusters.

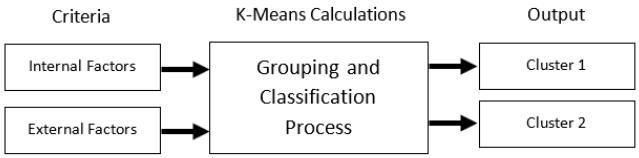

Fig. 5 System Diagram

Before creating a program, a flow chart is needed to compile the flow of programming logic. This flowchart starts with entering community data from questionnaires and suggestions. Then, the K-Means algorithm works to produce K-Means' calculations to display the results. The program ends after being entered into the database.

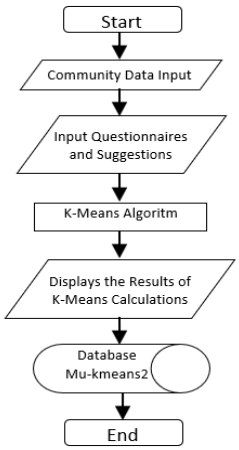

Fig. 6 Flowchart

C. Implementation and Unit Testing

The environmental office obtains information through the application as in Figure 7, either from the community or the sub-district level. For the admin, the menu consists of Population, District, and User Admin. Display the status of the amount of waste in the Makassar Environment Agency, consisting of a menu of residents, districts, and user admin. A list of rubbish dumps spread in Makassar city district can be accessed.

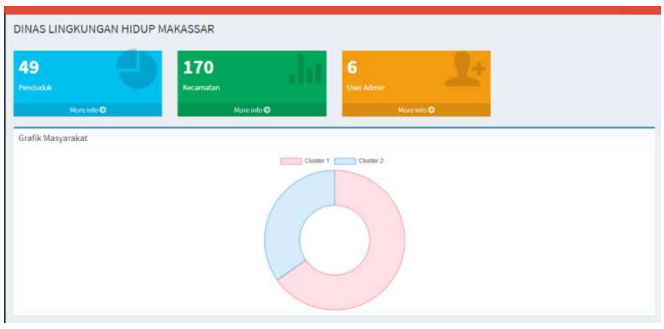

Fig. 7 Admin Information

The interview results are obtained in Figure 8 about the conditions in cluster 1 and cluster 2. Rapocini District ranks highest for cluster 1, and Panakukang District ranks lowest for cluster 2. There are 20 questions compiled based on a reference from a study entitled Community Behavior in Waste Management and Factors Affecting the District of Makassar City, South Sulawesi Province.

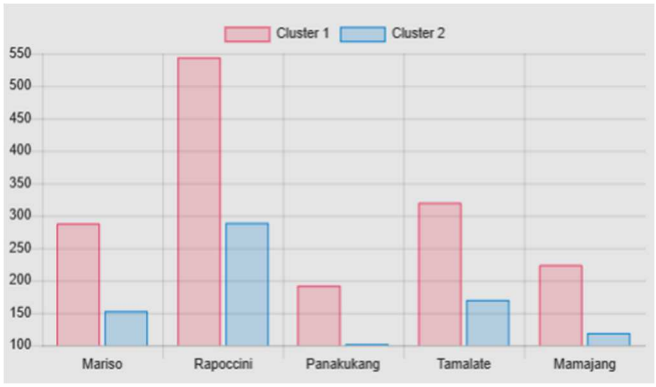

Fig. 8 List of Questions and Cluster Charts

D. Integration and System Testing

1) Context Diagram and Tiered Diagram: Stages implemented include Clustering Process 1 and Process 2. The questionnaire of Clustering Process 1 can be seen in Figure 9.

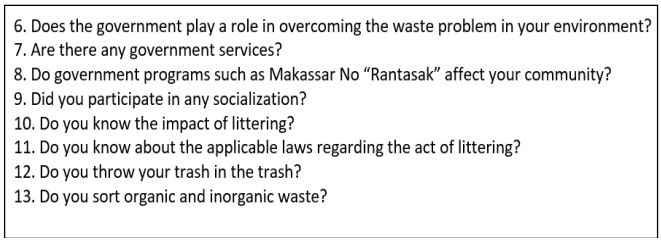

Fig. 9 Clustering Process 1

Calculation of K-Means Algorithm in the form of grouping or clustering data using calculations is subject to find the distance of data to the cluster's center. Figures 10 are the final data obtained after the calculation has stopped because there is no change in the cluster group. The results of calculations in the form of information about the state of cluster 1 or cluster 2 comprises a factor that influences the behavior of individual communities in disposing of waste.

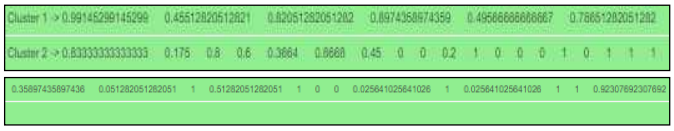

Fig. 10 Clustering Process 2

2) Determination of Variables: This stage determines the variables or parameters used in data processing on the system to be built with the K-Means algorithm. Variables are determined based on the analysis results in the field, namely in education, employment, leisure, knowledge, infrastructure, law, socialization, and the questionnaire results. Determination of variables is done by selecting the attributes that influence the community's disposal of waste. Here are some examples of complex variables used: educational, job, and free time variables.

TABEL II
EDUCATION VARIABLE

No.	Variable Name	Weight
1.	Primary School	0
2.	Junior High School	0.333
3.	Senior High School	0.667
4.	College	1

TABEL III
JOB VARIABLE

No.	Variable Name	Weight
1.	Does not work	0
2.	Student	0,25
3.	Housewife	0,50
4.	Employee	0,75
5.	Entrepreneur	1

TABEL IV
FREE TIME VARIABLE

No.	Variable Name	Weight
1.	1 – 3 hours	0
2.	4 – 6 hours	0,333
3.	7 – 9 hours	0,667
4.	> 10 hours	1

The amount of data used is 49 data from the community in five districts of Makassar, namely: Mariso, Mamajang, Rapoccini, Panakukkang, and Tamalate. In addition to community data, questionnaire data retrieval results are also attributing for calculations using algorithms.

3) Community Behavior: The following table is calculated based on cluster 1 and cluster 2, along with information.

TABLE V
COMMUNITY BEHAVIOR FACTORS

Data	Cluster 1	Cluster 2	Information
1	0.99	0.83	Knowledge
2	0.45	0.17	Means
3	0.82	0.8	Low
4	0.89	0.6	Socialize
5	0.49	0.36	Free time
6	0.78	0.86	Education
7	0.35	0.45	Job
8	0.05	0	Smoker (Quest.1)
9	1	0	Government role in the environment (Quest. 6)
10	0.51	0.2	Participation in socialization (Quest. 9)
11	1	1	Dispose of trash properly (Quest. 12)
12	0	0	Sort waste based on organic or nonorganic (Quest. 13)
13	0	0	Do waste processing (Quest. 14)
14	0.02	0	Reuse of thing (Quest. 15)
15	1	1	Use rechargeable item (Quest.16)
16	0.02	0	Use permanent bag(Quest. 17)
17	1	1	Reprimand other (Quest. 18)
18	1	1	Heaps a rubbish (Quest. 19)
19	0.92	1	Burning trash safely (Quest. 20)

Table 5 shows the factors included in class 2 (two), namely: cluster 1 and cluster 2, that influence people's behavior in disposing of waste. Mariso has 8 people (cluster 1) and 1 person (cluster 2). Rapoccini 15 people (cluster 1) and 2 people (cluster 2). Panakukkang 6 people (cluster 1) and none (cluster 2). Tamalate 6 people (cluster 1) and 4 people (cluster 2). Mamajang 4 people (cluster 1) and 3 people (cluster 2). Centroid value (average data) of cluster 1 has a difference in value greater than cluster 2 because the average value is based on calculating the results of the questionnaire answers filled by 49 people.

The conclusion of cluster 1 is that the community tends to give attention to the sub-district environment where they live. The community takes a role in processing the waste, using refill products, and using facilities properly. Moreover, the community knows the impact of applicable laws regarding waste disposal actions and participate in socialization activities carried out by the Makassar city government. Factors that influence people's behavior in disposing of waste can be seen in Table VI.

TABLE VI
INFLUENTIAL FACTOR

Sub-district	Cluster 1	Cluster 2
Mariso	8	1
Rapoccini	15	2
Panakukkang	6	0
Tamalate	6	4
Mamajang	4	3
Amount	39	10

The results of grouping in each sub-district can provide the information needed by various parties. This system provides recommendations for sub-districts that require special attention in waste management and quality of life monitoring by implementing a waste management performance development program.

E. Operation and Maintenance

1) Validity Test: A validity test is used to determine the extent and accuracy of a measurement instrument in carrying out its measuring function. Therefore, the data obtained is relevant following the purpose of measurement. The white box method is applied to measure logic performance based on the pseudocode created at the analysis stage.

```
39.     $training = mysql_query("select * from kuisioner");
40.     $totaldata = mysql_num_rows($training);
41.
42.     for($i =0; $i < $totaldata; $i++)
43.     {  1
44.
45.             if($hasil_tampung[$i][1] < 3)
46.             {
47.                 $hasil_tampung[$i][1] = 0;
48.                 $data1 = $hasil_tampung[$i][1];
49.             }
50.             if($hasil_tampung[$i][1] >= 4 && $hasil_tampung[$i][1] < 6)
51.             {
52.                 $hasil_tampung[$i][1] = 0.333;
53.                 $data1 = $hasil_tampung[$i][1];
54.             }
55.             if($hasil_tampung[$i][1] >= 7 && $hasil_tampung[$i][1] < 9)
56.             {
57.                 $hasil_tampung[$i][1] = 0.667;
58.                 $data1 = $hasil_tampung[$i][1];
59.             }
60.             if($hasil_tampung[$i][1] > 10)
61.             {
62.                 $hasil_tampung[$i][1] = 1;
63.                 $data1 = $hasil_tampung[$i][1];
64.             }
```

Fig. 11 The Pseudocode

The next step is testing the K-Means algorithm. Then, the form of pseudocode is changed to flowchart and flowgraph. The following coding piece is used to calculate the K-Means algorithm. Questionnaire data that has been successfully collected will become training data. Then, the training data experiences a looping function that aims to select the questionnaire data according to the predetermined categories. Training data is used to train algorithms, while testing data is used to determine previously trained algorithms' performance when finding new data that has never been seen before. This is usually called generalization. Tests are carried out to

measure the logic performance based on the pseudocode that has been made at the analysis stage. The following are the stages in testing the K-Means algorithm.

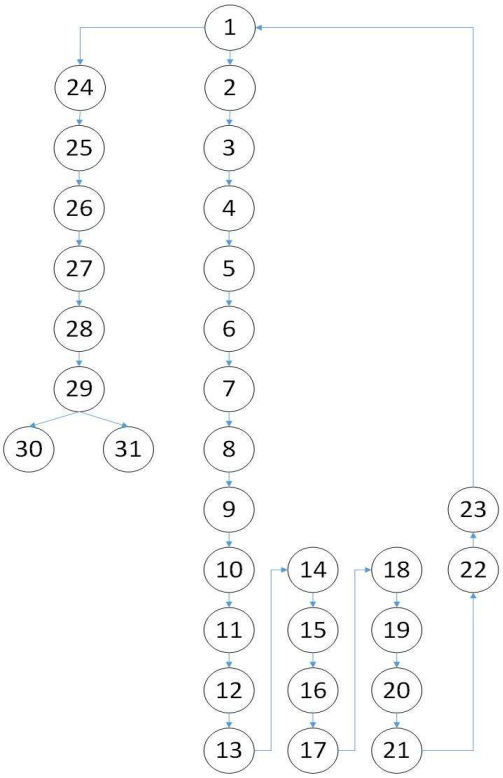

Fig. 12 Flowgraph K-Means Algorithm

2) Cyclomatic Complexity

$$V(G) = E - N + 2 \quad (2)$$

V(G) = 33 – 31 + 2
V(G) = 4
E = Number of Bows on flowgraph
N = Number of Vertices on flowgraph

3) Independent Path

Path 1:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 1, 24, 25, 26, 27, 28, 27, 29, 30

Path 2:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 1, 24, 25, 26, 27, 28, 27, 29, 31

Path 3:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 1, 24, 26, 27, 28, 29, 30

Path 4:
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 1, 24, 26, 27, 28, 29, 31

4) White Box Testing: Based on testing for each method, the Cyclomatic Complexity value generated is four. Therefore, it can be concluded that the white box testing on the K-Means algorithm runs well because each test produces the same value.

IV. Conclusions

The K-Means Algorithm application can help the City and Subdistrict Environmental Services in Makassar City know the factors that influence people's behavior in disposing of waste to be used as an evaluation material and reference to improve services the community in Makassar City. The system can help people get information about waste and the community based on the sub-district of residence and the community providing input to improve cleaning services in the sub-district community.

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References

[1] Nurlela. "The Impact of the Existence of the Vipa Mas 3R Waste Processing Site (Reduce, Reuse and Recycle) on the Socio-Economic Environment of the Community in Bambu Apus Village, Pamulang District, South Tangerang City". Thesis. Jakarta Universitas Islam Negeri (UIN) Syarif Hidayatullah, 2017.

[2] Sukerti, Sudarma, Pujaastawa, *Community Behavior in Waste Management and Affecting Factors in East Denpasar District, Denpasar City*, Bali, 2017.

[3] Notoatmodjo, Soekidjo, *Behavioral Health Sciences*, Jakarta: Rineka Cipta, 2010.

[4] Elvi Anggraeni Tjandra dan Siska Rosiani Tjandra, "The Relationship Between Cognitive Components, Affective Components and Behavior Components Towards Consumer Attitudes Using Internet Technology", Jurnal Manajemen/Volume XVII, No. 1, Pg. 42-52, February 2013.

[5] Mulasari A., Heru H. A., and Muhadjir N., *Analysis of the Situation of the Yogyakarta City Waste Problem and its Prevention Policies*, Jurnal Kesehatan Masyarakat Vol. 11 No. 2. dx.doi.org/10.15294/ kemas. vllil.3521, 2016.

[6] Sahil J *et al*., *Waste Management and Effort Management System in Dufa-Dufa Village, Ternate City*, Jurnal Bioedukasi Vol. 4 No. 2. ISSN: 2301-4678/ media.neliti.com, 2016.

[7] WHO, *Waste and human health: Evidence and needs*, Bonn, Germany, 2015.

[8] Nilam S.P. "Analysis of Solid Waste Management in Banuhampu District, Agam Regency", Jurnal Kesehatan Masyarakat Andalas Vol. 10 No. 2. Pg. 157-165. E-ISSN 2442-6725/jurnal.fkm.unand.ac.id/ index.php/jkma/, 2016.

[9] Loudon, David and J. Della Bitta, *Consumer Behavior: Concept and Applications*, *4th Edition*. New York: Mc. Graw Hill, 1993.

[10] Walgito, B, *Introduction to General Psychology*, Yogyakarta: Andi Offset, 2010.

[11] https://nasional.kompas.com/read/2018/11/22/15323351/sampah-dan-plastik-jadi-ancaman-seperti-apa-kebijakan-pemerintah?page=all Accessed January 25, 2020.

[12] Dubey, P. Singh, P. Yadav, and K. K. Singh, "Household Waste Management System Using IoT and Machine Learning," Procedia Comput. Sci., vol. 167, pp. 1950–1959, 2020.

[13] Kamal, Fitrul, “Relationship between Knowledge Level and Attitude of Housewives on Waste Management in Communities Around the Beringin River in RW 07 Wonosari Village, Ngaliyan District, Semarang City”, Thesis. Universitas Negeri Semarang. 2009.
[14] Pemerintah Republik Indonesia, *UU No. 18 Tahun 2008 tentang Pengelolaan Sampah.*
[15] Kota Makassar, *Peraturan Daerah Nomor 4 Tahun 2011 Tentang Pengelolaan Sampah*.
[16] Suwono, Tuwo, Haryati, Anshary, “Applying Organic Fertilizer from Solid Waste of Super Intensive Shrimp Pond on Production of Milkfish Fingerlings Chanos chanos”, IJASEIT Journal, Vol.10 No. 2. ISSN: 2088-5334, 2020.
[17] Kristianto, Maria Kurniawan, Jenny Soetedjo, “Utilisation of Papaya Seeds as Natural Coagulant for Synthetic Textile Coloring Agent Wastewater Treatment”, IJASEIT Journal, Vol. 8 No. 5. ISSN: 2088-5334, 2018.
[18] Alessandra Pieroni,Noemi Scarpato,Luca Di Nunzio,Francesca Fallucchi and Mario Raso,"Smarter City: Smart Energy Grid based on Blockchain Technology," *International Journal on Advanced Science, Engineering and Information Technology*, vol. 8, no. 1, pp. 298-306, 2018. [Online]. Available: http://dx.doi.org/10.18517/ijaseit.8.1.4954.
[19] Raviya, K. H. dan Gajjar, B, *Performance Evaluation of Different Data Mining Classification Algorithm Using WEKA*. Indian Journal of Research. II (1), 2013.
[20] Rohmawati, N. Defiyanti, S. Jajuli, M, “Implementation of the K-Means Algorithm in Clustering Scholarship Applicants”. Jitter Jurnal Ilmiah Teknologi Informasi Terapan. 2015. Vol. I (2). 62-68.
[21] Sommerville, Ian, *Sofware Engineering 9th ed*, New York, 2011.
[22] Prasetyo, E. *Data Mining Concepts and Applications Using MATLAB*, Yogyakarta: Andi Offset, 2012.
[23] Rui Xu and Donald C. Wunsch II, *Clustering*, A John Wiley & Sons, Inc., Publication, 2009.
[24] Yudi, Agusta, “K-Means-Penerapan, Permasalahan dan Metode Terkait. Denpasar”, Bali: Jurnal Sistem dan Informatika, Vol. 3, 47-60. February 2007.