Waste Banks Management Information System Using K-Means Cluster Approach Based On Geographic Information System

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Abstract. Natural disasters due to climate change can cause thousand tons of waste and the loss of human life, environmental damage and also economic losses each year. One of the ways to increase the effectiveness of waste management is by conducting waste banks activities as a community based environmental governance. Here, waste banks can be considered as a valuable economic commodity and savings. The supporting factor for the success of waste banks activity is through a technological instrument as a community based management which encourage the innovations for developing waste banks to be more effective and integrated. The method applied to the waste banks management system is a combination of the k-means cluster and the geographic information system (GIS) to identify groups of waste banks that have identical types of waste and also their distribution. The waste banks information system is able to provide information of the distribution of waste, waste production, the selling price of waste, and also groups of waste banks that have identical types of waste. The data used are 50 waste banks over a period of 8 months. The waste banks information system is able to perform classification in order to evaluate thedistribution of waste.

1 Introduction

Natural disasters due to climate change can cause thousands of tons of waste and the loss of human life, environmental damage, and economic losses each year [1]. One of the ways to increase the effectiveness of waste management is by conducting waste banks activities as a community based environmental governance. Waste bank, a community-owned business that considers wasting a valuable economic commodity and savings, has instruments involving the community in waste management [2].

Previous research found that the environmental and social weaknesses of the system can be minimized with the application of an integrated system [3]. One method to support an integrated information system is K-Means Clustering. This method has high effectiveness

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due to several advantages, including having various function formulations with minimal variance loss, describing alternative loss functions in the same class, variable pre-processing, and providing various methods of selecting the number of clusters and initialization and data reduction schemes. [4].

Computing the information system in this study is visualized through a Geographic Information System (GIS); the area of differences in the characteristics of each group can be displayed in the form of a map. The resulting map can be helpful for monitoring and analysing areas with similar levels of waste characteristics. Computing the information system in this study is visualized through a Geographic Information System (GIS); the area of differences in the characteristics of each group can be displayed in the form of a map. The resulting map can be helpful for monitoring and analysing areas with similar levels of waste characteristics. This study proposes an idea to overcome the problem of waste management by utilizing the Waste Bank Information System called *Si Basah* using the k-means cluster method integrated with GIS. It is expected to support more appropriate decision making. This study proposes an idea to overcome the problem of waste management by utilizing the Waste Bank Information System using the k-means cluster method, which is integrated with GIS so that it is expected to support more appropriate decision making.

2 Methods

2.1 K-Means Cluster

Clustering is a data analysis tool widely applied in various disciplines, such as bioinformatics, marketing, and image segmentation. Its wide use may not come as a surprise, as its intuitive purpose of dividing data into similar clusters applies to various stages of the analysis process, from exploratory data analysis to collaborative filtering. [5].

Cluster analysis is usually used to multivariate group data on k variables X1; X2; ...; Xk uses a proximity index generally represented by distance. Group analysis will combine similar data in one group, which means that observations close to each other form a group [6].

The K-Means algorithm iteratively increases the variation in the value in each cluster where the next object is placed in the closest group, calculated from the canter point of the cluster. The new midpoint is determined when all data have been placed in the nearest cluster. The process of determining the midpoint and placing data in clusters is repeated until the midpoint values of all formed clusters do not change anymore [7].

K-means algorithm:

1. Specifies how many k clusters of the dataset to divide.
2. Grouping the data so that K clusters are formed with the centroid point of each cluster being the centroid point that has been previously selected using the following Euclidean Distance.

$$[(x,y),(a,b)] = \sqrt{(x-a)^2} + \sqrt{(y-b)^2} \quad (1)$$

3. Update the centroid point value.
4. Repeat steps 2 and 3 until the value of the centroid point no longer changes.

2.2 Geographic Information System

A geographic information system (GIS) is designed to capture, store, manipulate, analyse, manage and present all types of spatial or geographic data and help visualize, question and interpret data to understand relationships, patterns and trends. [8].

Today, integrated GIS technology has been recognized as one of the most promising approaches for automating waste planning and management processes [9].

3 Implementation

The following is an information system process design framework that starts from the input. Processing and processing are carried out; the last one produces output or results in information. The design of the information system framework of the Waste Bank Management Information System is depicted in the following figure.

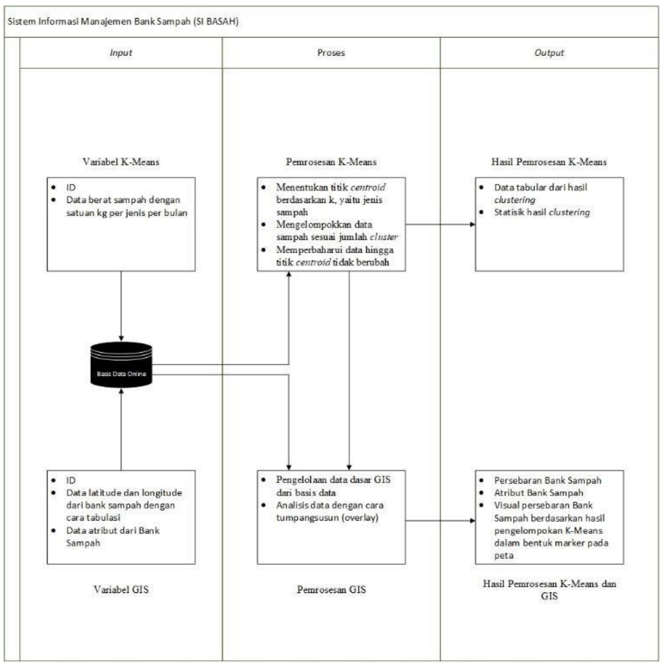

Fig 1. Information system framework

The three main things that form an information system are the input, process, and output. The input in the waste bank information system is in the form of waste data; its attributes include the month at the time of waste sorting, the year at the time of waste sorting, the mass of waste in units of Kg per type of waste, and the price of waste per Kg per type of waste. The types of waste determined are paper/newspaper, duplex, cardboard, plastic cups, plastic bottles, glass, cans/iron, aluminium/cider, paste, and mixtures. These data are the raw material calculated by the K-Means method, to be divided into several groups. Furthermore, the results of the K-Means are visualized in the form of a waste distribution map using GIS.

4 Results and Discussion

This study used data from 50 (fifty) waste banks in Semarang City (Indonesia) from January 2019 to August 2019. The use of the K-Means method in this information system shows the closeness of the characteristics of each waste bank based on mass (in units of Kg) per type per month. Table 1 shows the results of the K-Means calculation in January 2019 by sorting 3 clusters. Figure 3 shows the results of a GIS visualization of the distribution of waste using January data by sorting into 3 clusters.

Table 1. K-Means result

No.	Waste Bank Name	Cluster	Month - Year
1	Kemijen 1	3	January - 2019
2	Pundi Sekar Melati	*Non Cluster*	January - 2019
3	Berkah Bahari	*Non Cluster*	January - 2019
4	Melati	3	January - 2019
5	Mawar	3	January - 2019
6	Amarilis	*Non Cluster*	January - 2019
7	Sri Rejeki	1	January - 2019
8	Bina Artha Mulia	3	January - 2019
9	Guyub Rukun	3	January - 2019
10	Aisah	3	January - 2019
11	Bina Mandiri 3	3	January - 2019
12	Mekar Jaya	3	January - 2019
13	Gares	*Non Cluster*	January - 2019
14	Quarter Ceria	*Non Cluster*	January - 2019
15	Melati Putih	*Non Cluster*	January - 2019
16	Mawar	3	January - 2019
17	Seroja Asri	3	January - 2019
18	Mentari	3	January - 2019
19	Rejo Asri	3	January - 2019
20	Mandiri	3	January - 2019
21	Raflesia	1	January - 2019
22	Sekar Arum	3	January - 2019
23	Mulyo Sedoyo	2	January - 2019
24	Mawar Merah	3	January - 2019
25	Resik Becik	3	January - 2019
26	Limbah Berkah	3	January - 2019
27	Durian	3	January - 2019
28	Waras	3	January - 2019
29	Melati	3	January - 2019
30	Lestari Apl Jomblang	3	January - 2019
31	Omah Resik	3	January - 2019
32	Gedawang Asri	1	January - 2019
33	Payung Lestari	1	January - 2019

No.	Waste Bank Name	Cluster	Month - Year
34	Mekar Sari	3	January - 2019
35	Lumintu	3	January - 2019
36	Tinjomoyo Asri	1	January - 2019
37	Sari Asri 1	3	January - 2019
38	Resik Sejahtera	1	January - 2019
39	Bangkit Sejahtera	3	January - 2019
40	Mulyo Sejahtera	*Non Cluster*	January - 2019
41	Guyub Rukun	3	January - 2019
42	Mandiri 7	3	January - 2019
43	Makmur Abadi	3	January - 2019
44	Mugi Berkah	3	January - 2019
45	Bina Lestari	1	January - 2019
46	Gemah Ripah	3	January - 2019
47	Gemah Sentosa	3	January - 2019
48	Seroja Rowosari	3	January - 2019
49	Berkaryaling	3	January - 2019
50	Pendawa Berjaya	3	January - 2019

The results of the K-Means calculation in January show the results of the distribution of waste as follows:

a. Plastic / newspaper
Plastic/newspaper waste is included in the *large* category in cluster 2; cluster 1 hasa *medium* category, with *slightly* category in cluster 3.

b. Duplex
Duplex waste is included in the *large* category in cluster 2; cluster 1 has a *medium* category, with *slightly* category in cluster 3.

c. Cardboard box
Cardboard waste is included in the *large* category in cluster 2; cluster 1 has a *medium* category, with *slightly* category in cluster 3.

d. Plastic cups
Plastic cup waste is included in the large category in cluster 2, cluster 1 has a *medium* category, with *slightly* category in cluster 3.

e. Plastic bottles
Plastic bottle waste is included in the large category in cluster 1; cluster 1 has a *medium* category, with *slightly* category in cluster 3.

f. Non-bottle plastic
Non-bottle plastic waste is included in the large category in cluster 2; cluster 1 hasa *medium* category, with *slightly* category in cluster 3.

g. Glass
Glass waste is included in the large category in cluster 1; cluster 1 has a *medium* category, with *slightly* category in cluster 3.

h. Cans / iron
Canned/iron waste is included in the large category in cluster 2; cluster 1 has a

medium category, with *slightly* category in cluster.

i. Aluminium
Aluminium waste is included in the large category in cluster 2; cluster 1 has a *medium* category, with *slightly* category in cluster 3.

j. Solid waste
Solid waste in January in cluster 1, cluster 2, and cluster 3 which has a value of 0.

k. Mixture
Mixed waste is included in the large category in cluster 1; cluster 1 has a *medium* category, with *slightly* category in cluster 3.

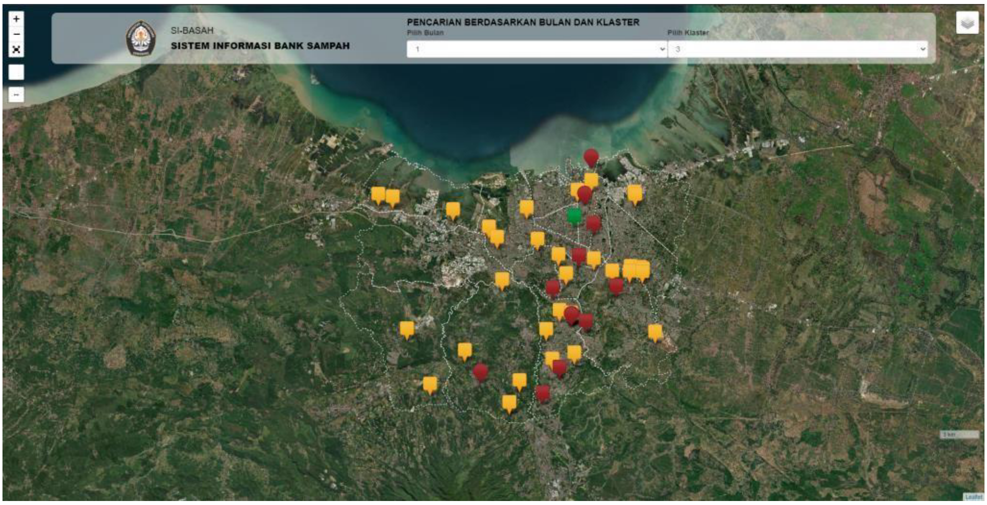

Fig 2. Waste distribution visualization

Cluster 1 is visualized with red markers, cluster 2 is green, cluster 3 is orange. Markers with different shapes in red are non-cluster data, meaning that the waste bank does not have data in the selected month.

5 Conclusion

The Waste Bank Information System using the K-Means method can classify to evaluate the distribution of waste; in this study, the GIS method is used to determine optical engineering in the form of interactive maps obtained based on the input data values in the form of latitude and longitude from each Waste Bank in Semarang City and waste mass per type per month for K-Means data input. Data processing by the system to get the results of the distribution of waste per month. The results show that the system can be used by the design that has been made.

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