APPLICATION OF DATA MINING IN SELECTING SUPERIOR PRODUCTS USING THE K-MEANS AND K-MEDOIDS ALGORITHM METHODS

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Abstract: As a supermarket, we are committed to always improving everything, including selecting the greatest goods. To evaluate which items are more superior or popular and which are less popular, you will want a sizable amount of information sources. To select products and identify those that belong in the superior product cluster, researchers employed the clustering method. The clustering strategy uses two forms of cluster analysis, k-means and k-medoids, which have related techniques. The research results show that the k-means algorithm's Davies Bouldin value is -0.430, whereas the k-medoids algorithm's Davies Bouldin value is -1.392. This suggests that the Davies Bouldin value of the k-medoids approach is the lowest, showing that the grouping findings of the k-means method are a better method to apply to the issue of choosing better products.

Keywords : k-means; k-medoids; clustering; algorithm; data mining

Abstract: Sebagai toko sembako, toko yuli berkomitmen untuk selalu meningkatkan segalanya, termasuk memilih barang terbaik. Untuk mengevaluasi item mana yang lebih unggul atau populer dan mana yang kurang populer, Anda memerlukan sumber informasi yang cukup banyak. Untuk memilih produk dan mengidentifikasi produk yang termasuk dalam cluster produk unggulan, peneliti menggunakan metode clustering. Strategi clustering menggunakan dua bentuk analisis cluster, k-means dan k-medoids, yang memiliki teknik terkait. Hasil penelitian menunjukkan nilai Davies Bouldin pada algoritma k-means sebesar -0,430, sedangkan nilai Davies Bouldin pada algoritma k-medoids sebesar -1,392. Hal ini menunjukkan bahwa nilai Davies Bouldin pada pendekatan k-medoids paling rendah, menunjukkan bahwa temuan pengelompokan metode k-means merupakan metode yang lebih baik untuk diterapkan pada permasalahan pemilihan produk yang lebih baik.

Keywords : k-means; k-medoids; clustering; algoritma; data mining

INTRODUCTION

Opening up trade between nations and expanding access to other countries' product markets is becoming more and more important due to the evolution of the global economy and the pattern of relations between nations, which typically indicate that the distance between one country and another one is reducing[1]. Financial transparency and Trade presents opportunities as well as challenges all at once. The increasing openness of commerce between nations can provide both problems to the competitiveness of domestic industries selling goods abroad and opportunities for improved domestic product market access. In theory, free trade can yield economic gains by broadening market

accessibility and augmenting the aggregate economic surplus[2]. However, free trade will not work provide great benefits if the competitiveness of domestic companies is much lower compared to overseas companies[3].

As a basic food store that distributes and handles logistics for consumer goods, Yuli Sembako Store is dedicated to constantly improving all elements of its business, including identifying outstanding products. Yuli Sembako Store uses the clustering approach to sort products and determine which ones are part of the superior product cluster. Organizing several records, observations, or other situations into a distinct class according to comparable items is known as clustering[4].

The two types of cluster analysis used in the clustering approach are k-means and k-medoids, and they have related methods. Research conducted easier for consumers to get information on the categories of goods to be purchased by applying the k-means and k-medoid algorithms[5]. The difference in the number of clusters in the performance of each algorithm has a mode The calculations are different for each literacy, depending on the data set used and the points centroid which is calculated in the algorithm[6].

The research was conducted at a moving shop in the consumption sector. Study This takes object data at the Yuli grocery store with several products ranging from rice, oil, sugar and others, these categories are the needs most frequently required by customers so there needs to be the ability to Estimate the sales volume of each product for sale. Customer satisfaction is always a priority meet customer needs[7]. These needs based on the history of sales that have been made so that it can be a reference in improving quality next products in stock planning to target better sales so that it can provide satisfaction for customers .

The k-means and k-medoids algorithm comparison approach was utilized by researchers to handle data[8]. In this research is: using data mining with k-medoids and k-means, where these two algorithms are grouped obtain the same thing but in a different way, k-means is by taking the average value, while k-medoids is by taking the middle value[9]. The research results show that both methods produce the same group, namely recommendations for the taste of authentic Thai milk tea and milk tea based on value research targets centroid of 0.286[10].

METHOD

In the research method there are several work sequences that must be followed, this work sequence is the steps that must be followed and carried out according to the main problem so as not to deviate from the specified problem boundaries[7]. The framework of thought used in carrying out this research is as shown Image 1.
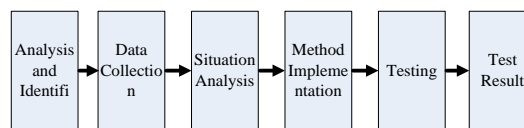

Image 1. The framework Of Thought

From Image 1 above it can be illustrated that the research stages are carried out by analyzing and identifying the problem to be researched, then data collection is carried out, from the data a situation analysis is carried out and the method to be used can be implemented, then testing is carried out to obtain test

results.

Application of Methodology
Data Collection

The warehouse stock and sales report data from the Yuli Sembako Store were directly collected to supply the data for this investigation. The research data includes product code, product name, transaction date, sales amount and inventory amount[8]. The data used is sales transaction data for 6 months, namely May to October 2023. After the data is obtained, the data is used to find out what products are included in superior products or products that are in high demand and which products are less popular.

Data Selection

Sales data and warehouse stock data are filtered first and several attributes are taken from the table for analysis[9]. There are three attributes used, namely, item code, average sales for 6 months from May to October 2023 and warehouse stock data for October 2023.

Table 1. Data Selection

Data Ke-	Kode Produk	Rata-Rata Penjualan	Stok Terakhir
1	Pl-0001	104	95
2	Pl-0002	156	116
3	Pl-0003	140	205
4	Pl-0004	124	219
5	Pl-0005	97	115
6	Pl-0006	17	50
7	Pl-0007	7	20
8	Pl-0008	61	38
9	Pl-0009	8	16
10	Hhc-0010	64	80
11	Hhc-0011	6	2
12	Hhc-0012	64	102
13	Hhc-0013	3	5
14	Hhc-0014	8	20
15	Hhc-0015	22	1
16	Enn-0016	65	48
17	Enn-0017	20	20
18	Enn-0018	31	30
19	Enn-0019	25	26

20	Enn-0020	33	14
21	Enn-0021	14	12
22	Enn-0022	58	98
23	Enn-0023	41	154
24	Enn-0024	27	551
25	Enn-0025	1	1
26	Gs-0026	-	-
...	....	..	.....
27	Gs-0027	-	-
28	Gs-0028	-	-
29	Gs-0029	-	-
30	Gs-0030	-	-
31	Gs-0031	-	-
32	Gs-0032	-	-
33	Gs-0033	-	-
34	Gs-0034	-	-
35	Gs-0035	33	81
36	Gs-0036	19	96
37	Gs-0037	4	26
38	Gs-0038	1	2
39	Gs-0039	1	8
40	Gs-0040	1	1
41	Gs-0041	16	51
42	Gs-0042	19	26
43	Gs-0043	20	25
44	Gs-0044	66	112
45	Gs-0045	60	98

Data Pre-Processing

After the data has been selected and selected according to the attributes to be used, pre-processing of the data is carried out, so that there is no duplication of data, no missing values and corrects errors in the new data in Excel format[10]. Data that has passed the pre-processing stage will be saved in a new data set using Microsoft Office Excel.

Data Conversion

The data change operation is now finished in order to process the data using the k-means and k-medoids algorithms[11]. Data that is not numeric is converted to numeric form. However, no commencement is necessary if the data you currently have is numerical.

Data Entry

At this point, the outcomes of the data transformation are used for data

modeling. This study used the k-means and k-medoids algorithms as its technique. The selected data will be processed using the clustering method[12]. This method works by grouping data that has similar characteristics in each data. The data has two variables (x and y) for easy visualization in Cartesian coordinates:

a. Variable X = Average sales for 6 months (May – October 2023)

b. Variable Y = Stock of goods in warehouse (30 October 2023)

K-Means Algorithm

Determining the initial centroid, this determination is carried out randomly on the existing data table. The calculation process in the k-means algorithm starts from iteration 1 (one). First, the distance from each data to all existing centroids is calculated[13]. From the results of calculating the distance between each data to all centroids, the smallest distance value to one centroid is obtained, then that centroid is called the closest centroid, and the data will be affiliated into a cluster from the closest centroid.

Table 2. Initial Centroid

Centroid	X	Y
C0	1	1
C1	77	166
C2	27	551

Formula 1 is used to find the distance between each available piece of data and the centroid value.

$$De = \sqrt{(Mix - Cix)2 + (Miy - Ciy)2} \quad (1)$$

K-Medoids Algorithm

K-Medoids performs grouping by using representative objects (medoids) as the cluster center for each cluster[14].

The k-medoids algorithm goes through the following steps:

Determine the desired k (number of clusters) for the previously collected data processed.

The desired cluster consists of 3 clusters, namely cluster 2 is a superior product or a product that is in high demand, cluster 1 is a product that is in moderate demand, and cluster 0 is a product that is in low demand or is not selling well. Select centroid points randomly or sequentially from k initial medoid data.

Table 3. Medoids data

Clusters	Data To-	X	Y
C0	89th data	16	22
C1	71st data	30	52
C2	82nd data	66	112

Calculate each data set's distance using k centroid points and the formula [15]. Calculating the separation between the data and the centroid point can be done in a number of ways. The following formula will be used in this study to estimate distances:

$$d1 = \sqrt{(X1 - Xc0)2 + (Y1 - Yc0)2} \quad (2)$$

1. Perform medoids iteration by calculating the distance using one of the distance calculation methods, for all data used as process data.
2. Randomly selecting non-representative objects (non-medoids).

Table 4. Non Medoids Data

Clusters	Data To	X	Y
C0	25th data	1	1
C1	5th data	97	115
C2	24th data	27	551

Using all of the data's distance computation results, compute the total deviation (S). And do another iteration of

the calculation with a new centroid point, using the initial steps again. The new centroid point is drawn randomly from the medoids data [16] . If a is the total calculation of the closest distance using the initial medoids, and b is the total calculation of the closest distance between the object and the new medoids, then the total deviation can be calculated using the equation formula.

$$S = \text{New total cost} - \text{Old total cost} \quad (3)$$

Information:
S=Difference
New total cost = Total cost for non-medoids
Old total cost = Total cost for medoids
So we get:
Because the S value > 0, the clustering process can be stopped.

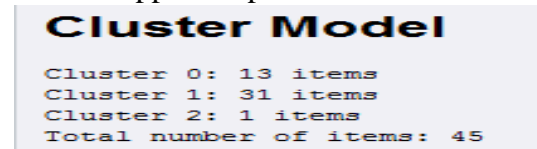$$S= 61,920–19,857=42,063$$

RESULTS AND DISCUSSION

Following k-means algorithm computations, the following product code information are obtained: cluster 0 has 32 products, cluster 1 has 12 items, and cluster 2 has 1 product.

1) Cluster 0 = PL-006, PL-007, PL-008, PL-009, HHC-011, HHC-013, HHC-014, HHC-015, ENN-016, ENN-017, ENN-018, ENN-019, ENN-020, ENN-021, ENN-025, GS-026, GS-027, GS-028, GS-029, GS-030, GS-031, GS-032, GS-033, GS-034, GS-035, GS-037, GS-038, GS-039, GS-040, GS-041, GS-042, GS-043.
2) Cluster 1 = PL-001, PL-002. PL-003, PL-004, PL-005, HHC-010, HHC-012, ENN-022, ENN-023, GS-036, GS-044, GS-045.
3) Cluster 2 = ENN-0024.
   Meanwhile, there are 27 products in cluster 0, 6 products in cluster 1, and 12 goods in cluster 2, according to the results of the computation using the k-medoids algorithm. The product codes are as follows: 1) Cluster 0 = PL-007, PL-009, HHC-011, HHC-013, HHC-014, HHC-015, ENN-017, ENN-018, ENN-019, ENN-020, ENN-021, ENN-025, GS-026, GS-027, GS-028, GS-029, GS-030, GS-031, GS-032, GS-033, GS-034, GS-037, GS-038, GS-039, GS-040, GS-042, GS-043., 2) Cluster 1 = PL-006, PL-008, ENN-016, GS-035, GS-036, GS-041., 3) Cluster 2 = PL-001, PL-002, PL-003, PL-004, PL-005, HHC-010, HHC-012, ENN-022, ENN-023 , ENN-024, GS-044, GS-045.
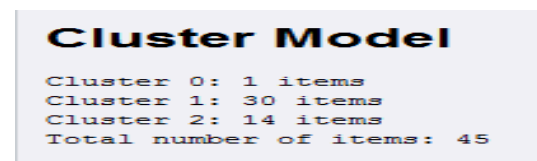
Test Results

The software used to analyze and carry out testing is RapidMiner Studio. Since Rapidminer is standalone software, it is compatible with all operating systems and is developed in Java. The following are the membership outcomes that this approach produced:

Cluster Model

Cluster 0: 13 items
Cluster 1: 31 items
Cluster 2: 1 items
Total number of items: 45

Image 2. Results of k-means clustering

Cluster Model

Cluster 0: 1 items
Cluster 1: 30 items
Cluster 2: 14 items
Total number of items: 45

Image 3. Results of k-medoids clustering

Cluster or the cluster with the least interest is cluster 0, judging from the value of the benchmark stock. Then the cluster with moderate interest is cluster 1 which can be seen from the next distance which is closest to the lowest cluster . The highest cluster or the cluster

with the most interest is cluster 2, This is depicted in the image.

Attribute	cluster_0	cluster_1	cluster_2
Rata-Rata P	78.923	12.355	27
Stok Terakhi	120.846	14.258	551

Image 4. Results of k-means cluster data

Attribute	cluster_0	cluster_1	cluster_2
Rata-Rata P	27	20	60
Stok Terakhi	551	25	98

Image 5. Results Of K-Medoids Cluster Data
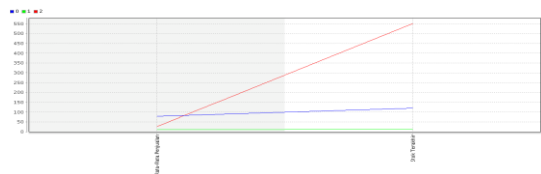
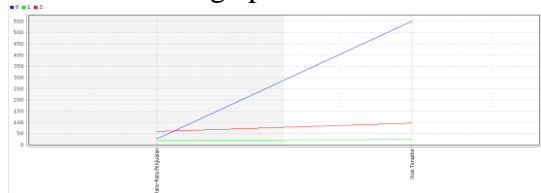Image 6. Results of k-means cluster graph data

Image 7. Results of k-medoids cluster graph data

Performance Vector is used to compare the two clustering methods' respective performances in order to decide whether algorithm is better suited for the task of choosing superior products at the Yuli Sembako Store. Based on the cluster centroid, the Performance Vector offers a list of performance criteria values.
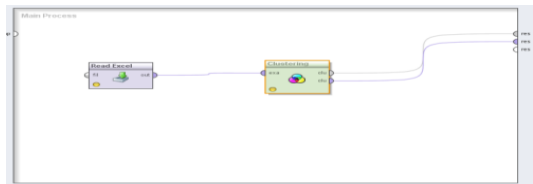

Image 8 . Cluster validation Main criteria of the Performance Vector

Average inside cluster distance (Avg_within_centroid_distance) is the result of averaging the distances between each cluster instance and the centroid. Davies_bouldin: An method producing clusters with low intra-cluster distance and large inter-cluster distance will have a low Davies Bouldin index. Based on this criterion, the best clustering method is the one that generates a set of clusters with the smallest Davies Bouldin index.

PerformanceVector

```
PerformanceVector:
Avg. within centroid distance: -0.436
Avg. within centroid distance_cluster_0: -1.358
Avg. within centroid distance_cluster_1: -0.000
Avg. within centroid distance_cluster_2: -0.161
Davies Bouldin: -0.430
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Image 9. Vector K-Means Performance Results

PerformanceVector

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PerformanceVector:
Avg. within centroid distance: -0.759
Avg. within centroid distance_cluster_0: -5.281
Avg. within centroid distance_cluster_1: -0.128
Avg. within centroid distance_cluster_2: -1.075
Davies Bouldin: -1.392
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Image 10. Performance Results of Vector K-Medoids

Based on these findings, it is evident that the k-means algorithm's Davies Bouldin value is -0.430, while the k-medoids method's Davies Bouldin value is -1.392. When it comes to selecting superior products at the Yuli Sembako Store, the k-means technique is a better option for grouping results, as seen by the fact that the k-medoids approach's Davies Bouldin value is the lowest.

CONCLUSION

On the results and discussion, the conclusion of this research is that with 45 product samples, sales reports and warehouse stock data, two clustering methods can be applied, namely the k-means and k-medoids algorithms at the Yuli Sembako Store, after carrying out the calculations you can The grouping of

products that are superior products, products that are in moderate demand, and products that are less popular are known. By implementing the clustering method, the problem of stock shortages in superior products can be overcome, because companies can see the results of grouping products with high, medium and low demand. For those included in the superior product grouping, the company will pay more attention to availability, so that there is no shortage of stock. And for goods that are less popular, companies do not need to stockpile goods which will result in high and uneconomical storage costs.

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