Research Article

Optimization of K-Means Clustering Method by Using Elbow Method in Predicting Blood Requirement of Pelamonia Hospital Makassar

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Abstract: Hospitals require an adequate supply of blood to meet patient needs. Accurate prediction of blood demand is essential to optimize inventory management and avoid shortages or overstocks. This study aims to predict blood demand at Pelamonia Hospital using K-Means Clustering and Elbow methods. Historical data on blood demand at Pelamonia Hospital was collected and processed. The Elbow method is used to determine the optimal number of clusters in the K-Means Clustering algorithm. Sum of Squared Errors (SSE) or Within-Cluster Sum of Squares (WCSS) values were calculated for various clusters, and the elbow point on the graph of SSE/WCSS vs. number of clusters was identified as the optimal number of clusters. Once the optimal number of clusters is determined, the K-Means Clustering algorithm is applied to the blood demand data, resulting in grouping the data into specific clusters. Each cluster is analyzed to find interesting patterns or characteristics, such as clusters with high or low blood demand. From the results of the SSE calculation process on 1057 blood demand data, the result that has the biggest decrease is at k = 4 with a difference value of 2754.90. The clustering results and patterns found are used to predict future blood demand by identifying which cluster best fits the current or expected conditions. The characteristics of the clusters are used to estimate the likely blood demand. This approach provides valuable insights into blood demand patterns and enables hospitals to better anticipate blood demand, thereby optimizing inventory management and improving the quality of healthcare services.

Keywords: Prediction Blood Needs; Hospital; K-Means clustering; Elbow method; SSE

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1. Introduction

Hospitals are like windows of hope for those fighting against illnesses and injuries. Behind their white walls, the spirit of medical and non-medical personnel shines as they struggle to save lives. In there, stories of human persistence and resilience are beautifully etched. However, behind the noble efforts of medical heroes, there is a crucial need that must not be overlooked, which is blood. Blood is the essential life fluid in various medical procedures, from surgeries, and transfusions, to the treatment of critical illnesses. Blood is not just a red liquid flowing in our bodies. Blood is a vital component that sustains human life. Its diverse functions make it an important element in maintaining health and survival [1]. According to an article by the Directorate General of Health Services of the Ministry of Health of the Republic of Indonesia, every country, including Indonesia, requires a blood supply of at least around 2% of the total population. However, based on data from https://dataindonesia.id/as of June 14, 2023.

Blood is a vital component in modern healthcare services. Hospitals need an adequate supply of blood to perform various medical procedures, such as surgeries, transfusions, and patient care for certain conditions. A shortage of blood supply can threaten patient safety and hinder the provision of timely care. However, estimating a hospital's blood needs often presents a challenge. Blood demand can fluctuate significantly depending on the number of patients, types of medical conditions, and other factors that are not easily predictable. Excess bloodstock can lead to resource wastage and the risk of expiration, while a shortage can be fatal for patients.

To address this issue, Pelamonia Hospital needs an effective method to predict blood needs more accurately. One promising approach is to use data clustering techniques with the K-Means Clustering algorithm and the Elbow method. This method can identify patterns in historical blood demand data and group them into different clusters [3]. By analyzing the characteristics of each cluster, such as high or low blood demand levels, the hospital can gain valuable insights into the factors contributing to blood demand fluctuations. This information can be used to predict future blood needs more accurately, allowing the hospital to optimize blood inventory management and avoid shortages or excess stock.

To strengthen the problem background, the author includes a journal related to the algorithm researched by Muningsih and Kiswati titled "Application System Based on Optimization of the Elbow Method for Determining Customer Clustering." In this study, it is explained that data processing using the K-Means method and the optimization of the Elbow method by knowing the SSE (Sum of Square Error) value resulted in 3 customer groups with the maximum or best value, with an SSE difference of 3,124,559.296 [4].

There is also related research conducted by D. I. Ramadhani, O. Damayanti, O. Thaushiyah, and A. R. Kadafi titled "Application of the K-Means Method for Clustering Disaster-Prone Villages Based on Natural Disaster Occurrence Data." In this study, 3 clusters were determined, with cluster 1 being the most popular product, cluster 2 the popular product, and cluster 3 the less popular product. The study used 5 product categories, each with 10 types of products. Calculations using Ms. Excel showed that cluster 1 had 18 members, cluster 2 had 6 members, and cluster 3 had 26 members. Calculations using RapidMiner revealed that cluster 1 had 22 members, cluster 2 had 5 members, and cluster 3 had 23 members. Cluster evaluation with DBI yielded a fairly good result with a value of 0.431. Accuracy, recall, and precision measurements from Ms. Excel calculations were 62%, 67%, and 59%, respectively. Calculations using RapidMiner resulted in an accuracy of 64%, recall of 81%, and precision of 88%. The clustering comparison results showed that calculations using RapidMiner achieved higher accuracy, recall, and precision values [5].

Moreover, the K-Means Clustering and Elbow methods have advantages in their ability to analyze large amounts of data and handle high-dimensional data. This method separates data based on its characteristics, so similar data is grouped into one cluster, while different data is grouped into different clusters [6]. This makes the method suitable for application to complex and multidimensional hospital blood demand data. By implementing this method, Pelamonia Hospital hopes to improve the efficiency of blood inventory management, ensure adequate blood availability, and ultimately enhance the quality of healthcare services for patients.

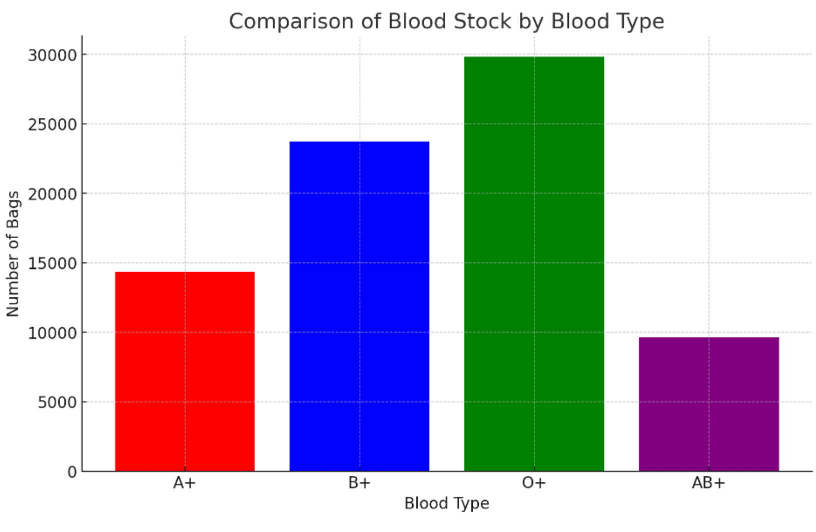

Figure 1. Indonesia's Blood Stock Inventory Data as of June 2023 (source: https://dataindonesia.id/) [2]

In Figure 1, we can see data from Indonesia's Blood Stock Inventory Data as of June 2023, specifically the blood types and the number of blood bags available are as follows, A+ 14,336, B+ 23,743, O+ 29,825, and AB+ 9,633 bags.

2. Research Methodology

2.1 Data Mining

The research begins with preparing the data for testing. Data preparation follows the steps outlined in Knowledge Discovery in Databases (KDD). According to Larose, there are several stages in the data mining process, starting from data selection, data cleaning process, data transformation process, data mining process (or the process of finding patterns or information from selected data), and the final stage is the interpretation and evaluation stage, which results in new and useful information [7].

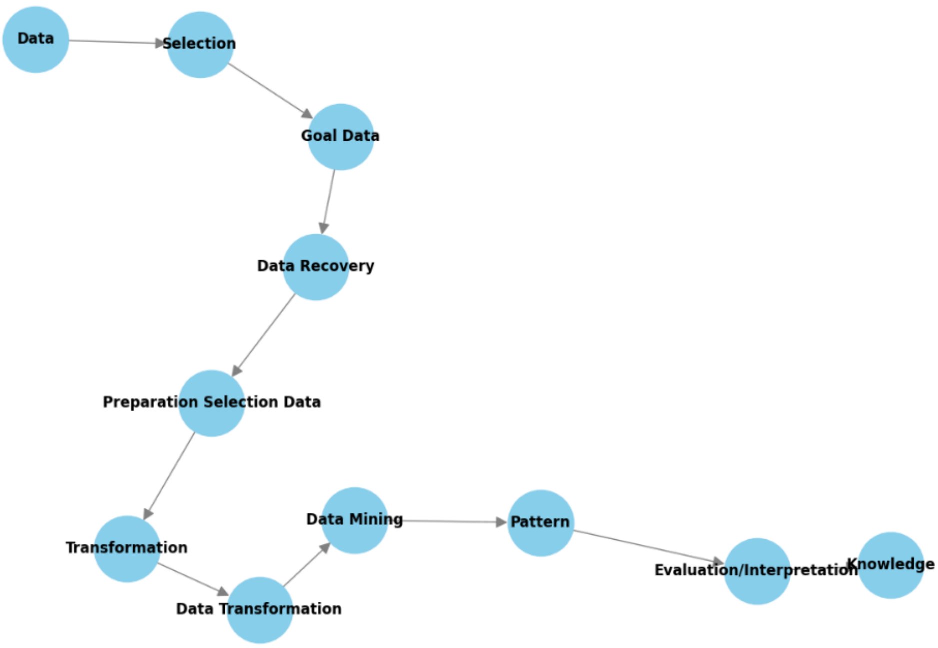

Figure 2. Data Mining Stage Source: (Jollyta et al, 2020) [8]

The stages carried out in the data mining process begin with data selection, data preprocessing, data transformation, data mining, and interpretation/evaluation. In detail, it is explained as follows :

1. Data Selection
   Data selection from a set of operational data needs to be done before the information mining stage in KDD (Knowledge Discovery in Database). The selected data will be used in the data mining process.
2. Pre-processing / Cleaning
   The cleaning process includes removing duplicate data, checking for inconsistent data, and correcting errors in the data.
3. Transformation
   This transformation process is a process where the data that has been selected will be converted into a form where the data can be processed in data mining.
4. Data Mining
   Data Mining is the process of finding interesting patterns or information in selected data using certain techniques or methods.
5. Interpretation / Evaluation
   The information patterns generated from the data mining process need to be displayed in a form that is easily understood by interested parties.

2.2 Data Collection

This study aims to optimize the K-Means Clustering method in predicting blood demand at Pelamonia Hospital Makassar using the Elbow Method. Data were obtained from medical records and the bloodstock management system at Pelamonia Hospital Makassar. The data includes information on daily blood demand and usage over the past year (2023). The collected variables include blood type (A+, A-, B+, B-, AB+, AB-, O+, O-), date of blood request, number of units of blood requested, and the type of medical procedure requiring blood.

2.3 Modeling Methodology

2.3.1 K-Means Clustering

After the test data has passed through these stages in the KDD process, the data is ready for the next stage, which is determining the number of k clusters to be tested. Once the number of k clusters is determined, the data is tested using the K-Means algorithm based on the value of k. Among the many clustering algorithms, the K-means clustering algorithm has been studied at a deeper level and has been maturely applied in some fields [9]. The K-Means algorithm is a data analysis method that performs data clustering using a partitioning system. To obtain the optimal number of clusters for the K-means clustering the most common algorithms used are the Elbow method and the Silhouette method [10].

According to Yahya and Mahpuz [11], the K-Means algorithm is a model that uses centroids to create clusters. Centroids are the central points of clusters. Generally, the K-Means algorithm involves the following steps :

1. Determine k as the number of clusters to be formed.
2. Determine k initial centroids (initial center points of clusters) randomly.

   Moreover, the formula used to calculate the centroid of the next *i*-th cluster is as follows equation 1.

$$v = \frac{\sum_{i=1}^{n} x_i}{n}; i = 1, 2, 3, \dots n \quad (1)$$

Where v is the centroid in the cluster, xi is the i-th object, and n is the number of objects or numbers. Next, calculate the distance of each object to each centroid of each cluster. To calculate the distance between objects and centroids can use Euclidean Distance, as shown in Equation 2.

$$d(x, y) = \|x - y\| = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2; i = 1, 2, 3, \dots, n} \quad (2)$$

Where xi is the i-th x object, yi is the y-i data, and n is the number of objects.

1. Allocate each object to the closest centroid.
2. Perform iteration, then determine the new centroid position using equation (1).
3. Repeat step 3 if the new centroid position is not the same [12].

2.3.2 Elbow Method

After passing through the K-Means algorithm process, the clustering results for each k will be validated using SSE and the Elbow method. According to Putu [13], the Elbow Method is used to generate information for determining the optimal number of clusters by examining the percentage comparison results between the number of clusters (k) that form an elbow at a certain point. Likewise, the study used Sum Squared Error (SSE) to improve the performance of the Elbow method [14]. Moreover, The value of k in the elbow combination with K-Means is the graph of the cluster relationship with the decrease in error [15]. The number of clusters k resulting from testing with K-Means is evaluated using the SSE technique [16]. SSE (Sum of Square Error) is a formula used to measure the difference between the obtained data and the previously estimated model [17]. To calculate SSE, the formula is as follows equation 3.

$$SSE = \sum_{k=1}^{k} \sum_{x_i e S_k} \|x_i - y_k\|_2^2 \quad (3)$$

The SSE value obtained will be tested using the Elbow method to determine the optimal number of clusters. After obtaining the optimal number of clusters, information on the clustering results based on the optimal clusters is obtained [18].

3. Result and Discussion

3.1 Training Data

The blood demand data consists of a dataset comprising 1057 records that will be converted into numerical form. The data is displayed in Table 1.

Table 1. Blood Demand Data

No	Date	Day	Blood Type	Need	Usage	Month	Year
1	1	Sunday	A+	5	Surgery	January	2023
2	1	Sunday	A-	4	Childbirth	January	2023
3	1	Sunday	O+	4	Trauma	January	2023
4	2	Monday	A-	3	Trauma	January	2023
5	2	Monday	O-	5	Childbirth	January	2023
…	…	…	…	…	…	…	…
1055	29	Wednesday	B+	3	Childbirth	December	2023
1056	30	Thursday	O-	3	Surgery	December	2023
1057	31	Thursday	B+	4	Trauma	December	2023

After processing the initial dataset, the first step is to convert categorical values into numeric ones to facilitate the K-means algorithm. The 'Blood Type' column is transformed from strings like 'A+' or 'O-' into numbers 1 to 8. The 'Requirement' column is also converted, with categories such as 'Surgery' and 'Childbirth' being assigned numbers 1 to 3, and the month names in the 'Month' column are changed to numbers 1 to 12. This process helps the K-means algorithm to effectively and consistently process the data. After conversion, the Elbow method is used to determine the optimal number of clusters.

3.2 K-Means Clustering Results

The K-Means method, as one of the well-known clustering algorithms, can be utilized to identify customer segmentation results through the process of cluster division [19]. The blood demand data was tested using the K-Means algorithm with the number of test clusters ranging from k=2 to k=10. The number of members in each clustering is displayed in the following Table 2.

Table 2. K-Means Clustering

Number of k	Number of Cluster Members (Data)
2	528
4	264
6	176
8	132
10	107

3.3 SSE and Elbow Evaluation Results

From the calculation process of SSE on 1057 blood demand data, the greatest decrease was observed at k=4 with a difference value of 2754.90. This can be seen in the following Table 3.

Table 3. SSE Results for Each Cluster

Cluster (k)	SSE Result	Difference
2	19268.58	-
4	16513.68	2754.90
6	14344.11	2169.57
8	12631.43	1712.68
10	11510.01	1121.42

3.4 Clustering Information

Based on Table 3, the highest difference value is at k=4, which is 2754.90. This value indicates that the optimal cluster is found at k=4. Therefore, aside from being optimal clusters, the information contained within them is also the most valuable.

3.5 Implementation in Python

In our research to created a python program using the K-Means Algorithm, which is well-known as one of the clustering methods that can be used to identify customer segmentation results through the cluster division process [20]. The k-means algorithm is very commonly used in practical applications due to its simplicity and computational efficiency [21]. The purpose of the K-means clustering model is to partition the data space into discrete zones and to determine the appropriate zone to which each data point should be allocated [22] The Python execution results for clustering using K-means are as follows. Below is the SSE graph executed with Python.

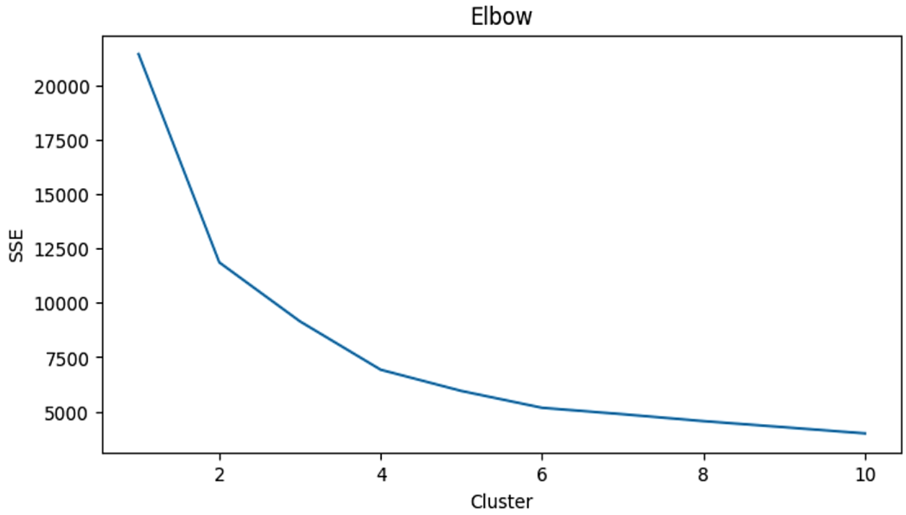

Figure 3. SSE Graph (Elbow)

The generated graph shows a significant decrease in inertia up to the 4th cluster, after which the decrease slows down, indicating that the optimal number of clusters is 4. With this number of clusters, K-means partitions the data into 4 groups based on blood type, requirement, usage, and month. Each data point is assigned a cluster label, and these results are saved in a CSV file for further analysis.

The Elbow method determines the optimal number of clusters by identifying the point where the inertia decrease starts to slow down. The inertia graph shows a significant decrease up to the 4th cluster, after which the decrease becomes less pronounced, thus indicating that 4 clusters are optimal. This provides a balance between model complexity and its ability to effectively group the data.

The K-means algorithm with 4 clusters maps the data into more homogeneous groups based on important features. These clusters reflect patterns in blood demand at hospitals, such as the dominance of certain blood types at specific times or for specific uses like surgeries or childbirth. This segmentation helps identify demand patterns, which can be used for bloodstock management, demand prediction, and logistical planning. Overall, clustering with K-means and the Elbow method provides valuable insights into blood demand patterns in hospitals, aiding in stock management and medical needs planning.

Table 4. SSE result comparison

Previous Research	**Data Count**	**Optimal Cluster**	**SSE Result**
K-Means Cluster Optimization Using Elbow Method on Drug User Data with Python Programming [23].	1000	3	2328,052
Application of Data Mining Using the K-Means Method to Find out Customer Interest in Purchasing Kpop Merchandise [24].	1500	2	2548.192
Optimization of National Exam Score Clustering with K-Menas, Elbow, and Silhouette Algorithm Approaches [25].	1536	3	717, 4831

Previous studies focused on different contexts such as drug users, customer interest in K-pop merchandise, and national exam scores. This study uniquely applies the K-Means Clustering and Elbow method to predict blood demand in hospitals, specifically Pelamonia Hospital Makassar. This study identifies the optimal number of clusters (k=4) for predicting blood demand, while previous studies had different optimal clusters (k=2 or k=3). The SSE value at k=4 in this study is significantly lower, indicating more accurate clustering for this context. The SSE result of 16513.68 for k=4 in this study demonstrates an improvement in clustering accuracy compared to previous studies. This reduction in SSE indicates better optimization of clusters for predicting blood demand. This study provides practical insights for hospital management in optimizing blood inventory, directly contributing to improved healthcare services and patient safety. This practical application distinguishes this study from previous theoretical studies.

3.6 Prediction

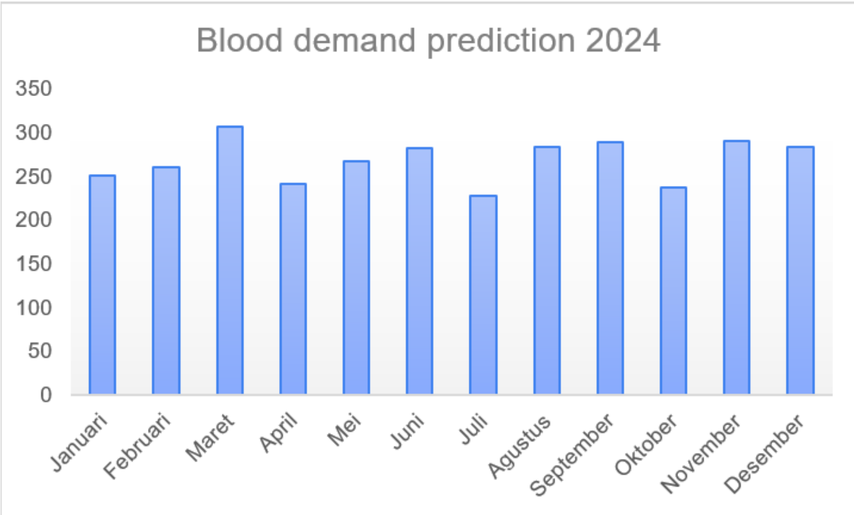

Figure 4. Predicted Blood Demand 2024

Based on Figure 4, it is found that March recorded the highest blood demand with 307 bags. July recorded the lowest blood demand with 228 bags. Blood demand is relatively high in February, March, June, August, September, November, and December. The average monthly blood demand is 268.25 bags. There is a tendency for an increase in blood demand during the holiday season (June-August) and the end of the year (November-December). With this analysis, Pelamonia Hospital Makassar can better plan and meet the blood demand throughout the year.

5. Conclusion

Based on the discussion conducted on the prediction of blood demand in the hospital, it can be concluded that the K-Means and Elbow Method approaches are effective in identifying the optimal number of clusters and discovering patterns in the hospital's blood demand dataset. These results can be used to improve blood stock management strategies and demand planning based on historical data. O- blood type has the highest overall blood demand. Blood demand for A+ and AB+ blood types is generally low. Blood demand for B- and O+ blood types is typically moderate. March has the highest blood demand due to the beginning of the disease season and many surgeries taking place. For future research, deeper analysis could consider additional factors such as seasonal trends, patient demographics, and disease patterns throughout the year. Additionally, the application of other prediction methods such as Principal Component Analysis (PCA), Silhouette Analysis, and Hierarchical Clustering is expected to provide more accurate and comprehensive results.

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can be useful for all those who are learning about K-Means Clustering Method using Elbow Method in particular.

Author contributions: All authors are responsible for building Conceptualization, Methodology, analysis, investigation, data curation, writing—original draft preparation, writing—review and editing, visualization, supervision of project administration, funding acquisition, and have read and agreed to the published version of the manuscript.

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References

1. Mulawati, A Pratama, Mas Rahman Ismail, Abdul Ali, Satriadi D, "Sistem Informasi Stok Darah Real Time Berbasis Android Pada Palang Merah Indonesia (Pmi) Kabupaten Gorontalo", 2022
2. "Stok Darah di Indonesia Sebanyak 77.438 Kantong per 14 Juni 2023", dataindonesia.id. Jun.14, 2023. Accessed: Jun. 27, 2024. [Online]. Avalilable: https://dataindonesia.id/varia/detail/stok-darah-di-indonesia-sebanyak-77438-kantong-per-14-junihttps://dataindonesia.id/varia/detail/stok-darah-di-indonesia-sebanyak-77438-kantong-per-14juni-2023
3. J. Hutagalung and F. Sonata, "Penerapan Metode K-Means Untuk Menganalisis Minat Nasabah Asuransi," vol. 5, pp. 1187–1194, 2021, doi: 10.30865/mib.v5i3.3113.
4. Afiasari, Nur Suarna, Nana Rahaningsi, Nining, "Implementasi Data Mining Transaksi Penjualan Menggunakan Algoritma Clustering dengan Metode K-Means" , 2020.
5. D. I. Ramadhani, O. Damayanti, O. Thaushiyah, and A. R. Kadafi, "Penerapan Metode K-Means Untuk Clustering Desa Rawan Bencana Berdasarkan Data Kejadian Terjadinya Bencana Alam," JURIKOM (Jurnal Ris. Komputer), vol. 9, no. 3, p. 749, Jun.2022, doi: 10.30865/jurikom.v9i3.4326.
6. M. R. Nugroho, I. E. Hendrawan, and P. P. Purwantoro, "Penerapan Algoritma K-Means Untuk Klasterisasi Data Obat Pada Rumah Sakit ASRI," J. Nuansa Inform., vol. 16,no.1, pp. 125–133, 2022, doi: 10.25134/nuansa.v16i1.5294.
7. Larose, "Discovering Knowledge in Data: An Introduction to Data Mining," pp. 129–240,2005.
8. D. Jollyta, W. Ramdhan, and M. Zarlis, Konsep Data Mining Dan Penerapan, Pertama.Yogyakarta: Deepublish, 2020.
9. WU Guangjian,ZHANG Jianlin,YUAN Ding. Research on automatic method of obtaining K value based on elbow method based on -means[J].Software,2019,40(05):167-170.)
10. T. M. Kodinariya and P. R. Makwana, ''Review on determining number of cluster in K-means clustering,'' Int. J., vol. 1, no. 6, pp. 90–95, 2013.
11. Yahya and Mahpuz, "Penggunaan Algoritma K-Means Untuk Menganalisis Pelanggan Potensial Pada Dealer SPS Motor Honda Lombok Timur Nusa Tenggara Barat," Jurnal Informatika dan Teknologi., vol. 2, no. 2, pp. 109–118, 2019.
12. Ediyanto, N. Mara, and N. S. Intisari, "Pengklasifikasian Karakteristik Dengan Metode K-Means Cluster Analysis," Bul. Ilm. Mat. Stat. dan Ter., vol. 02, no. 2, pp. 133–136, 2013.
13. N. Putu, E. Merliana, and A. J. Santoso, "Analisa Penentuan Jumlah Cluster Terbaik pada Metode KMeans," pp. 978–979.
14. R. Nainggolan, R. Perangin-Angin, E. Simarmata, and A. F. Tarigan, "Improved the Performance of the K-Means Cluster Using the Sum of Squared Error (SSE) optimized by using the Elbow Method," in Journal of Physics: Conference Series, 2019, vol. 1361, no. 1, doi: 10.1088/1742-6596/1361/1/012015.
15. D. Jollyta, S. Efendi, M. Zarlis, and H. Mawengkang, "Optimasi Cluster Pada Data Stunting: Teknik Evaluasi Cluster Sum of Square Error dan Davies Bouldin Index," Pros. Semin. Nas. Ris. Inf. Sci., vol.1, no. September, p. 918, 2019, doi:10.30645/senaris.v1i0.100. Hal 815

16. D. Jollyta, S. Efendi, M. Zarlis, and H. Mawengkang, “Optimasi Cluster Pada Data Stunting: Teknik Evaluasi Cluster Sum of Square Error dan Davies Bouldin Index,” Pros. Semin. Nas. Ris. Inf. Sci., vol. 1, no. September, p. 918, 2019, doi:10.30645/senaris.v1i0.100. Hal 816
17. A. T. Rahman, Wiranto, and A. Rini, “Coal Trade Data Clustering Using K-Means (Case Study PT. Global Bangkit Utama),” ITSMART J. Teknol. dan Inf., vol. 6, no. 1, pp. 24– 31,2017, doi: 10.20961/ITS.V6I1.11296
18. Surapati, Untung Jannah, Magfiratul, “Penerapan Data Mining Menggunakan Metode K- Means Untuk Mengetahui Minat Customer Dalam Pembelian Merchandise Kpop”, Volume 5 No. 3 |Februari 2024 |pp: 875-884 Hal 878
19. Z. Salman and A. Alomary, “Performance of the K - means and fuzzy C - means algorithms in big data analytics,” Int. J. Inf. Technol., vol. 16, no. 1, pp. 465–470, 2024, doi: 10.1007/s41870-023- 01436-y.
20. B. Wan, W. Huang, B. Pierre, Y. Cheng, and S. Zhou, “K-Means algorithm based on multi-feature induced order,” Granul. Comput., vol. 9, no. 2, 2024, doi: 10.1007/s41066-024-00470-w.
21. W. Wu, W. Wang, X. Jia, and X. Feng, “Transformer Autoencoder for K-means Efficient clustering,” Eng. Appl. Artif. Intell., vol. 133, p. 108612, Jul. 2024, doi: 10.1016/j.engappai.2024.108612.
22. D. Parnes and A. Gormus, “Prescreening bank failures with K-means clustering: Pros and cons,” Int. Rev. Financ. Anal., vol. 93, p. 103222, May 2024, doi: 10.1016/j.irfa.2024.103222.
23. Winarta, Andre Kurniawan, Wahyu Joni, “Optimasi Cluster K-Means Menggunakan Metode Elbow Pada Data Pengguna Narkoba Dengan Pemrograman Python”, JTIK (Jurnal Teknik Informatika Kaputama), 2021, doi: 10.59697/jtik.v5i1.593
24. Surapati, Untung Jannah, Magfiratul, “Penerapan Data Mining Menggunakan Metode K-Means Untuk Mengetahui Minat Customer Dalam Pembelian Merchandise Kpop”, Volume 5 No. 3 |Februari 2024 |pp: 875-884 Hal 879
25. Lashiyanti, Allbila Rahajeng Rasyid Munthe, Ibnu Nasution, “Optimisasi Klasterisasi Nilai Ujian Nasional dengan Pendekatan Algoritma K-Means, Elbow, dan Silhouette”, Jurnal Ilmu Komputer dan Sistem Informasi (JIKOMSI), Volume 6, Nomor 1, Maret 2023, Hal 14-20