# ENHANCING EFFICIENCY IN DETERMINING QURAN LEARNING GROUPS: A WEBSITE-BASED K-MEANS ALGORITHM APPROACH AT NURUL JADID ISLAMIC BOARDING SCHOOL

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### Abstract

This research aims to develop a web-based application system using the K-Means algorithm to group students in Quran coaching at the Nurul Jadid Islamic Boarding School in Paiton, Probolinggo. The need for this system is based on the importance of efficiency and accuracy in determining student coaching groups based on their abilities in reading the Quran, including Tajweed, fluency, and memorization scores. This research method involves data analysis from 412 students. The data is processed using the K-Means algorithm to group students into three skill categories: "Good", "Sufficient", and "Poor". The grouping results provide objective and accurate guidance in determining suitable coaching groups for each student. The research results show that the K-Means algorithm is effective in grouping students, thereby improving the efficiency and accuracy of the coaching process. The implementation of web-based technology facilitates access and use of the system by administrators and coaching participants, ensuring that the grouping and coaching processes become faster, more accurate, and more objective. In conclusion, this research successfully develops a more responsive and efficient Quran coaching system, which not only solves specific problems at the Nurul Jadid Islamic Boarding School but also makes a significant contribution to the development of similar systems in other Islamic educational institutions.

Keywords: K-Means, Student Clustering, Quran Coaching, Data Mining, Website Technology.

### 1. INTRODUCTION

"The Islamic Boarding School Nurul Jadid, located in Paiton Probolinggo, plays a crucial role in delivering Islamic education with a focus on Islamic brotherhood [1]. One of the primary educational activities at Nurul Jadid is Quran training for students. A significant component of this training is grouping students based on their skills and individual needs. Currently, this grouping is done manually, requiring deep knowledge of each student's abilities and the varied learning targets of different groups. However, manual methods are susceptible to human errors in assessing students and assigning groups, besides being time-consuming and labor-intensive [2].

To enhance the efficiency and accuracy of Quran training group assignments, this research proposes the use of technology and data analysis methods, particularly data mining to identify relevant patterns and clustering using the K-Means algorithm [3]. This research underscores the need to improve the efficiency and accuracy of group assignments in Quran training [4]. Objectively evaluating student abilities poses challenges due to each student's unique characteristics, requiring considerations such as Quran reading ability, understanding of Tajwid (rules of Quranic recitation), and fluency in reading. Additionally, there are varying expected learning outcomes among training groups; some students may need additional assistance with basic Quranic concepts while others are ready for more advanced lessons [5].

In this scenario, data mining techniques and clustering offer more objective and efficient methods for group assignments [6]. Data analysis can uncover patterns in Ouran training test results, which can be used to assess student abilities [7]. Clustering, especially with the K-Means algorithm, allows for homogeneous grouping based on identified data characteristics [8]. The implementation of technology and data analysis methods in this research aims to address the challenges faced by the Islamic Boarding School Nurul Jadid. By leveraging technology, the grouping process can become faster, more accurate, and more objective, thereby enhancing student motivation through personalized training experiences tailored to individual needs [9]. The implementation plan includes using Python for data analysis, the K-Means algorithm, and developing a web interface with PHP for ease of access and use by administrators and training participants [10]. An SQL database will be used to ensure organized data storage that is easily accessible [11].

This research aims to address specific issues at the Islamic Boarding School Nurul Jadid and contribute to the development of a more responsive and efficient training system in similar educational institutions [12]. Furthermore, insights from related studies strengthen the foundation of this research. For instance, Ai Rohmah, Falentino Sembiring, and Adhitia Erfina (2021) highlighted the use of the K-Means algorithm to classify levels of learning barriers in the context of distance learning during the COVID-19 pandemic [13]. Similarly, Dian Permata Sari (2021) applied the K-Means algorithm to determine the spread levels of the COVID-19 pandemic in West Sumatra, clustering regions based on positive cases and virus spread [14]. Moreover, Achmad Dimyati (2023) focused on using K-Means to evaluate academic grades of students at TPO Darussalamah based on the Laravel Framework [15]. These studies collectively support the adoption of data mining techniques like K-Means for improving educational practices [16]. The integration of K-Means clustering into educational settings has shown promise in various studies, including its application in predicting student academic performance, analyzing students' academic data, and classifying student learning achievements [17]. Such applications illustrate the versatility of K-Means in educational data analysis and its potential to address complex challenges in student assessment and educational management these methodologies, leveraging [18]. By educational institutions can streamline processes, personalize learning experiences, and foster academic success [19]. This research builds on these foundations to propose a data-driven approach for enhancing Quran training at Nurul Jadid and similar institutions.

### 2. METHOD

The Quran Coaching Group Determination application system was developed using PHP programming language with the Laravel framework and an SQL database. The Knowledge Discovery in Databases (KDD) methodology was employed to analyze data in a structured way to extract new information [20]. Data mining processes involved applying clustering methods to uncover hidden information. The primary goal is to analyze the results of Quran coaching tests conducted by the Religious Affairs Bureau of Nurul Jadid Islamic Boarding School, Paiton, Probolinggo.

This research includes several stages outlining the research design: (a) Data Collection, (b) Understanding K-Means Clustering Literature on Data, (c) Data Processing, (d) Website Development, (e) Data Clustering Steps, and (f) Evaluation of Clustering Results. Figure 1 below illustrates the flowchart for determining clusters using the K-Means algorithm.



Figure 1. Research Steps

### 2.1. Data Collection

The data gathered consists of records from Quran coaching tests conducted by the Religious Affairs Bureau at Nurul Jadid Islamic Boarding School, Paiton, Probolinggo. A total of 412 test result records were collected, each containing individual scores for each tested surah. The collected data includes Tajweed, fluency, and memorization scores for each student involved in the Quran coaching activities.

# 2.2. Understanding K-Means Clustering Literature on Data

Once the data is properly collected, the next step involves understanding the concepts and theories underpinning data grouping using the K-Means Clustering method [21]. The process of grasping literature related to the application of K-Means Clustering on the gathered data entails several steps:

- a) Literature Review: Conduct searches and reviews of literature and research related to K-Means Clustering by examining articles, books, and scientific publications that discuss the foundational concepts, algorithms, and applications of K-Means Clustering across various fields [22].
- b) **Mathematical Concepts**: Explore the mathematical foundations of K-Means Clustering, including the calculations of distances between data points and centroids, as well as the optimization principles that drive the algorithm. This provides a thorough understanding of how the algorithm operates and its efficiency in data grouping [23].
- c) **Case Study Analysis**: Analyze case studies and practical implementations of K-Means Clustering in diverse contexts and sectors by reviewing how this method has been successfully used in real-world data analysis, noting its strengths and limitations[9].
- d) **Method Evaluation**: Assess the relevance and potential application of the K-Means method for analyzing the collected data by determining whether this method can effectively uncover significant patterns or insights within the data [24].

### 2.3. Data Processing

In this stage, data is cleaned, transformed, and prepared for clustering. The preprocessing steps include:

- a) Removing incomplete or irrelevant data.
- b) Normalizing data to ensure uniform scaling across all variables.
- c) Addressing any outliers, if necessary.
- d) Converting data into a format suitable for the K-Means algorithm.

### 2.4. Website Development

The next step involves creating the website interface to fulfill the system requirements. This web-based system is built using PHP with the Laravel Framework and an SQL database to facilitate easy access for calculating groupings in Al-Qur'an mentoring. The application of the K-Means Clustering Algorithm within the Laravel Framework includes performing calculations and applying them to the processed data.

### 2.5. Data Clustering Steps

The next step involves clustering the data using the k-means algorithm. This process includes testing the clustering both manually using Excel with a .xlsx format and using Python in Google Colab to ensure consistent data accuracy. The steps involved are as follows:

- a) Select the data to be clustered.
- b) Determine the number of clusters (k) to be created.
- c) Randomly choose initial cluster centers (centroids).
- d) Calculate the distance of each data point to the centroid using the Euclidean Distance formula.

$$D_{(i,j)} = \sqrt{(P_{1i} - Q_{1j})^2 + (P_{2i} - Q_{2j})^2 + \dots} + (P_{ki} - Q_{kj})^2$$

where  $D_{(i,j)}$  represents the distance from data point *i* to cluster center *j*,  $X_{ki}$  is the *k*-th attribute of data point *i*, and  $X_{kj}$  is the *k*-th attribute of cluster center *j*.

- e) Assign each data point to the cluster with the nearest center.
- Recalculate the cluster centers based on the mean of the data points in each cluster. The formula to calculate the cluster center is.

$$C_i = \frac{P1 + P2 + P3 + \dots + Pn}{\sum P}$$

where  $C_i$  is the cluster center, Pn is the *n*-th data point for the *n*-th attribute, and  $\sum P$  is the sum of all data points in the cluster.

g) Repeat the iteration until the cluster assignments remain unchanged.

### 2.6. Evaluation of Clustering Results

After the clustering process is completed, the results will be evaluated using the Davies-Bouldin Index calculation formula. The Davies-Bouldin Index calculation is based on the principle of maximizing inter-cluster distance while minimizing intra-cluster distance [25]. Therefore, it can be stated that the smaller the Davies-Bouldin Index value, the more optimal the clustering scheme. This evaluation will assist in determining the optimal number of clusters and in evaluating the quality of clustering produced by the K-Means algorithm [26]. The formula for calculating the Davies-Bouldin Index can be presented as follows:

$$DBI = \frac{1}{k} \sum_{i=1}^{k} \{R_i\}$$
  
where  $R_i = max_{j=1,...,k,i,\neq j} R_{ij}, R_{ij} = \frac{S_1 + S_j}{d_{ij}}$   
and  $S_1 = \left[\frac{1}{n} \sum_{x \in n_i} d^2(x, v_i)\right]^{\frac{1}{2}}$ 

In this equation, the symbol k represents the number of clusters, and  $R_{i,j}$  is a measure of similarity between the values  $n_i \, \text{dan} \, n_j$ . The symbol  $S_i$  represents the dispersion size of the *i*-th cluster, where i = 1.2.3, ..., k. The symbol  $d_{ij}$  indicates the distance between the centroid of cluster *i* and the centroid of cluster *j*  $(d_{ij} = d_{ji})$ . The symbol  $n_i$  indicates the number of members in cluster *i*, where i = 1.2.3, ..., k. Finally,  $v_i$  represents the centroid value of cluster  $n_i$ .

### 3. ANALYSIS RESULTS

The analysis results of predicting the grouping of Al-Qur'an mentoring using the K-Means algorithm are conducted by considering the tajwid score, fashohah score, and memorization score. Data from 412 students who participated in the Al-Qur'an mentoring test are collected and used in the grouping process.

The analysis results indicate that Al-Qur'an mentoring can be categorized into three different groups based on their proficiency levels in reading Al-Qur'an. These groups are labeled "good," "fairly good," and "less good" according to the characteristics of each group. The following are the results of implementing the K-Means algorithm-based website in determining the Al-Qur'an mentoring groups.

### 3.1 Data Collection

In this stage, 412 collected data points are utilized. These data encompass assessments from each surah examined in the Al-Qur'an mentoring. Subsequently, the scores from each test are aggregated to obtain the total score of the data. The following presents the results of the Al-Qur'an mentoring tests:

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,	12020311438	Achmat Suton Amination Kamala	Nanovi Al-Bartari	Wilayah Syelih Jumadi Kubro	Misila	30 3	28	30	30 3	0 30	30	30 30	30	30	30 3	30	30	30 30	30	30	30 31	10	30	30 3	30	30	30 3	30	30	30	10 3	30	30	30 3	396	32	0 388	1168	85.8
2	12020711426	ABF Dair Ainul Yaqin	Newski Al-Bartani	Wilayah Syelih Junadi Kubro	MtsHi	30 30	30	30	30 1	0 30	30	30 30	30	30	50 3	30	30	20 30	30	30	30 50	30	30	30 3	30	30	10 3	30	30	30	90 3	30	30	30 3	300	33	0 300	1170	92.0
3	12020111263	Ahmad Adi Sapukra	Navawi Al-Bartan	Wilayah Siyekh Jumatil Kubro	MTeRU	36 3	30	38	30 3	0 30	38	36 35	30	30	30	30	30	38 31	30	30	30 34	30	30	30 X	36	30	36 3	30	30	30	10 3	30	28	28 2	34	38	6 368	1954	89.5
+	12020511458	Ahmad Daniel Malasm Wala	Nanoni Al-Eastari	Wileyah Syelch Jurradi Kuteo	Misłw	30 3	33	30	30 3	0 30	30	30 30	30	30	30	10 10	30	32 31	30	30	30 30	20	30	30 3	30	30	10 3	30	30	30	10 3	30	30	30 2	38	39	0 388	1168	83.8
5	12020511218	Armad Mobulhas Narai	Newson's Al-Stantons	Wilayah Sysich-Jurnadi/Kulato	MTs-HJ	30 3	28	30	38 3	0 30	ж	30 30	30	30	30	10 30	30	30 30	30	30	30 50	30	30	30 3	30	30	30 3	- 20	30	30	33 3	30	33	33 3	396	28	6 38	1185	50.8
6	12020311370	Almsad Yazid Zidan Allintisp	Nanani Al-Bartari	Wilayah Systeh Jumadi Kubro	MTs-H2	30 3	30	30	30 .1	0 30	30	30 30	30	30	30 3	10 30	30	38 31	30	30	30 30	20	30	30 3	30	30	10 3	- 20	30	30	10 3	30	30	30 3	- 296	39	0 390	1179	92.0
7	12020511346	Alifan Nawal Haq	Namani Al-Bantari	Wileyah Dyekh Jurradil Kubro	MTs-RD	30 30	30	30	38 3	0 30	30	30 30	30	30	30 3	30 30	30	30 30	30	30	30 30	30	30	30 S	30	30	30 3	35	30	30	50 3	30	30	30 3	395	33	10 300	1170	90.0
	121203913732	Stellor Supolera Pratarna M.	Namoni Al-Boctori	Wileyah Sysich Janual Koleo	MTHE	30 38	30	33	30 3	6 33	30	30 33	33	30	33	16 10	33	13 31	л	33	30 33	33	30	33 3	30	33	13 3	10	33	30	13	28	33	33 3	428	43	2 30	1,236	95.1
3	12020911776	Gilang Kumawan Ramachan	Nanawi Al-Burtoni	Wilayah Synich Jurradii Kubro	MTS-RU	30 3	30	29	28 3	0 30	ж	28 30	30	28	36	30 30	30	30 30	30	30	30 30	20	30	30 3	30	30	30 3	30	30.	30	90 B	30	-30	30 3	300	39	8 38	1162	65.4
10	12020711250	Habi Michael Jörl	Navavi Al-Bartari	Wilayah Syekh Jumadi Kubro	Misel	30 3	30	30	30 3	0 30	30	28 30	30	30	36 3	30 30	30	30 30	30	30	30 30	32	30	30 3	30	30	30 3	30	30	30	8 3	39	30	30 3	25	39	2 388	1170	50.9
11	12020911464	M Faih Renaitors	Sanani Al-Bartani	Wilayah Syekh Jumadil Kuleo	MTHTM	30 30	30	20	30 3	0 30	30	30 30	30	30	30 3	10 20	30	30 30	30	30	30 30	30	30	30 3	30	30	30 3	30	30	30	30 3	30	30	30 3	38	29	0 300	1170	96.0
12	12020111485	SI. Calah Ali haraf	Nemovi Al Bartari	Wileyah Syekh Januati Kubro	MISHU	28 2	30	28	28 3	0 28	28	30 28	28	30	20 1	8 28	25	25 N	28	28	30 28	28	30	28 2	30	30	10 3	30	30	30	6.3	30	35	30 3	311	н	19 388	1128	86.8
13	12020111266	Mich. Aidy Rahdan Al-mahi	Stanowi Al-Bartlari	Wilayah Syekh Jumadil Kubio	MTHIN	27 25	25	27	27 3	0 27	27	30 27	27	30	27 3	17 30	27	27 M	27	27	30 27	27	30	28 2	30	28	28 3	28	28	30	17 2	7 30	v	27 3	39	35	4 365	1093	84.5
14	12020511221	Mich: Millahui Muhit	Navani Al-Bartari	Wileyah Siyekh Jurvadil Kubro	Misilia	38 2	30	30	38 3	0 30	28	30 30	30	30	50 :	30 30	30	30 30	30	30	30 50	30	30	30 3	30	30	x 3	30	30	30	xi 3	30	30	30 3	300	38	N 300	1164	69.5
15	12020111368	Moh Rahan Animal Fata	Nexavi Al Bartani	Wilayah Syelih Junadi Kubro	MTeHU	30 3	30	20	28 2	0 30	28	30 30	28	30	28 3	8 30	28	28 30	30	30	30 25	8	25	30 3	30	30	30 3	30	30	30	x 3	30	ж	30 3	379	37	8 385	1139	\$7.6
16	12020711078	Wolsenmad Anter Buen	Newini Al-Bartan	Wilayah Synith Amadii Rubro	Misilu	30 28	25	30	30 3	0 30	30	30 30	30	30	30 3	10 20	30	30 30	30	30	30 31	10	30	30 3	30	30	x0 3	30	30	30	x x	30	20	30 3	298	38	8 385	1103	69.5
17	12020511402	Multanomati Albon Iman Hada	Nensori Al-Bartani	Wilayah Synist Jamadi Kaleo	WINN	.25 2	25	30	25 3	n 30	30	25 30	30	30	30	30	25	30 25	30	30	30 30	29	30	20 2	10	30	20	36	30	30	10 3	30	35	25 3	- 380	34	0 260	1099	84.5
-						-	-	-	-		-		-	-	-		-		-	-		-	-		-	~		-	-	-		-	-	-	-	-	-	848	-
470	1000110549	ikbar Anugerah Bahi	Sunan Gin	Wileyah Syelih Jamadi Kabro	MA Negeri 1 Probolinggo	35 2	30	25	15	10 II	ж	30 X	30	30	30	15 30	15	30 8	35		30 2	5 30	30	22 3	30	30	20 A	25	25	30	15 3	s a	25	35 3	431	47	5 393	1240	96.6
411	12020510465	Farts Hilleri Adili'ye	Sunan Muria	Wifeyeh Syekh Januall Kabro	NSL Nageri 1 Protociergeo	35 3	30	35	35 1	0 35	15	30 31	35	30	33	10	33	н х	-13	10	30 3	30	35	30 3	10	15	15 3	35	35	30	15 1	8 30	13	20 3	340	44	1 300	1200	96.5
412	12020710526	A. Fatabilah	Sa'lé Al-Makki Al-Manduri	Wileyah Syekh Jumuell Kubro	MM Negeri 1 Proballegge	35 3	30	35	35	16 35	25	30 32	35	30	35	85 30	25	25 30	35	35	30 3	5 25	30	35 3	30	25	35 3	35	35	30	35 3	5 30	35	355 3	450	11	5 388	1618	124.5
-							-	-		-		-	-			-		-	-	-		-	-		-		-		-							-	-		

Figure 2. Results of Al-Qur'an Mentoring Tests Data.

In Figure 2, the total number of successfully acquired data points is depicted, while the data to be processed for determining the Al-Qur'an mentoring groups using the K-Means algorithm consist of the total scores of each data point.

### 3.2 Data Processing

In this stage, data processing is conducted to prepare the data. Data processing involves steps such as data cleansing, normalization, and data labeling or initialization..

### a) Data Cleansing

In the data cleansing stage, irrelevant data rows are removed for K-Means calculation. These data rows include columns not utilized in the analysis, such as Region, District, institution, and values from several tested surahs, including Surah At-Takasur, Al-'asr, Al-Humazah, Al-Fil, Quraisy, Al-Ma'un, Al-Kautsar, Al-Kafirun, An-Nasr, Al-Lahab, Al-Ikhlas, Al-Falaq, and An-Nas. This is performed because K-Means calculation only utilizes the total score from all tested surahs.

Table 1. Results of Irrelevant Data Cleansing.

NO	NILLID	NUME		VALUE	
NO	NIUP	NAME	Т	F	Н
1	12020311438	Achmad Sulton Amiruddin K	390	390	390
2	12020711426	Afif Dwi Ainul Yaqin	390	390	388
3	12020111253	Ahmad Adi Saputra	388	388	388
4	12020511458	Ahmad Daniel Mateen Wafa	390	390	388
5	12020511218	Ahmad Misbahus Sururi	396	396	388
6	12020311370	Ahmad Yazid Zidan Altintop	390	390	390
7	12020511346	Alifian Nawal Haq	390	390	390
8	12120913732	Brillian Saputera Pratama M.	426	422	388
9	12020911776	Gilang Kurniawan Ramadhan	388	388	386
10	12020711290	Habil Michael Jibril	390	392	388
11	12020911464	M Farih Romadhoni	390	390	390
12	12020111485	M. Galeh Al-hanef	371	369	388
13	12020111266	Moh. Adly Akhdan Al-mahi	354	354	385
14	12020511221	Moh. Miftahul Muhit	388	386	390
15	12020111368	Moh. Raihan Aminul Fata	379	375	385
408	11720502268	Ahmad Fahmy Kholidy	350	350	380
409	11720902259	Ahmad Imong Budiono	430	408	390
410	11720503113	Ahmad Zaidan Salim	305	310	390
411	11720302242	Aufil Ghulam	335	360	365
412	11820701873	Danil Faizin	335	335	365

### b) Data Normalization

Next, data normalization is not performed as a preparatory step before the clustering process using the K-Means algorithm. In this case, it is because the data to be processed already has a uniform scale range for each feature, and there are no features that dominate the clustering process.

### 3.3 Website Development

The next step in this research is the development of a website foundation using PHP programming language, Laravel framework, and SQL database. The purpose of this website is to present the processed data in an easily understandable and usable format. This website is also expected to facilitate administrators in accessing the data generated from the k-means algorithm calculations. Below are the appearance and features of the k-means algorithm website.

### a) Dashboard



Figure 3. Dashboard Interface Display.

### b) Variable Management

Masukkan Kata Kuns			
NO	KODE VARIABEL	NAMA VARIABEL	AKSI
1	Nitai T	Penilalan dari Tajwid Santri saat membaca Al-Qur'an	Tris Hapus
2	Nitai F	Penilalan dari Kefashihan (Fashohah) Santri saat membaca Ai-Qur'an	file Hapes
3	Nilai H	Penilaian dari Hafalan Santri saat membaca Al-Quiran	Edit Hapus

Figure 4. Variable Management Interface Display.

#### Data Management c)

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opert	Escal						
Chicose	File Into the choses	n		UNIOND			
Maid	ideam Kieta Karnol						
NO	NIUP	NAMA LENGKAP	WILAYAH	DAERAH	LEMBAGA	AKS	61
3	12020311438	Achmad Sulton Aminuddin Kumala	Syekh Jumetil Kubro	Navani Al-Bartani	MTs-NI	Tott Hapes	
2	12020711425	Afit Dwi Ainul Yaqin	Syekh Jumadil Kubro	Navani Al-Bartani	MTs-NI	tole Hapon	
3	12820111253	Ahmad Adi Saputra	Syekh Jumadil Kabro	Nevasi Al-Bartani	MTs-Ni	Edit Hapus	
4	12020511458	Ahmad Daniel Mateen Wafa	Syekh Jumashi Kubro	Navani Al-Bantani	MTs-Ni	tide Hapon	
5	12020511218	Ahmad Misbahus Sururi	Synkh Jurnadil Kubro	Navzui Al-Bartani	MTs-Ni	fide Hapon	
8	12820311370	Ahmad Xazid Zidan Atlintop	Syekh Jumedil Kubre	Neveni Al-Bartani	MTs-N/	Cda Bullett	

Figure 5. Data Management Interface Display.

#### d) **Cluster Management**

ritma K-N	deans 📔 Districtions	Manajorren Meiabel	Managemen Data	Manajemen Geater	Matodick Means	
inten Ca	itter					
landican I	úeta Kuno					
NO		NAMA CLUSTER			CENTROID AWAL	AKSI
1	Bak				Puser Awal	Edit Rapin
2	Cokup Balk				Point Awal	funt Mague
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Figure 6. Cluster Management Interface Display.

## f) K-Means Algorithm Iteration

						310	390	388	77.24957773719 1	2.038333303117 99.264	03676150 1	1.68833505117 C							
						306	396	355 6	1.765001750181 1	1.90071118587 107.62	1 101223193	1,90071118587 C	Zeinal		371	390	389	85.5626575519	119 21222155626
samples and send	Indep					310	290	290 7	7.250428548323 15	417370164781 59.642	92206874 15	417270164781 C	Ahmad Fahmy Kholidy		350	350	380	127.890933154	02 38.4038550130
						390	390	390 7	7 259428549523 15	417370164731 99:642	A2266874 11	A17370164281 C	Ahmed Imong Budion	e	430	405	390	34.0394153007	05 02,2514010501
Iterasi Ke 1						426	422	385 2	9.377178695299 4	2.74775451966 146.80	05728005 29		Ahmad Zaidan Salim		305	310	190	187.810818947	04 99,3093153931
CLUSTER:	NILAI TAJWID		NILAI FASHOHAH		NILAI HAFALAN			100.000	100000000000000000000000000000000000000		000000000000000000000000000000000000000		Aufil Ghulam		335	310	165	114.297313328	85 48.0343268511
C1	190		390		390	Iterasi Ke 4							Claril Fabrin		115	335	265	150:601355793	15 00.4433894740
C2	300		390		380	CLUSTER		NILAI TAJWID		NILAI FASHOHAH	li -	NILAI HARALAN							
C3	392		388		368	61		443.248		643,248		388.056	Iterasi Ke 7						
NO NUP	NAMA LENGKAP	NILAI 1A/W	ID NILAI FASHOHAH	NILAI MAJAL	AN CI	C2		386.30372746833		383.48734177215		377,01265822783	CLUSTER		NEAL TAJWID		NILAI FASHOH	aH	NILAI MAFALAN
1 12020011434	Achmad Suhon Aminuddin Kumala	190	390	390	0			354.50387596899		302,25356589147		356.0902240362	C1 -		440		445.104397167	112	187.35460992308
2 12020711424	Afri Dai Alcui Vecin	190	290	709	2	D NILAI FASHOR	ARE NILALISATA	LAN CI	a		JARAK TERDE	KAT CLUSTER	a		378.0632183500		371.965517241	38	376.47701149425
1 12020011251	Ahmad Arti Canutra	100	100	100	1464309615	200	201	7532913710	0141 14.0015860G	124.001207021402	14 00110606	MS Coloradak	a		287 62886597938		290,731958762	293	163.72164949454
	Abread Paralal Marine Mida	100	200	100		100	202	75 10405450	ALL TO MAKE THE	001 134 33412353734	12 38655 3544	1993 Colors Balk							
4 12020511458	Annual Carrier Mattern Mara	114	200	300	-	100	202	70.13249000	1472 1242402434		11 00045 3177	Company	350	390	345	103.07297467735	34,430346876095	119.15148063196	34.430046876095
5 12020511218	Ahmad Misbahus Soturi	396	396	388	8.717797887	2003	.94	78,15,289096	2467 11.998452672	232 121.32199993976	11.998452872	SSS COMPANY	350	270	370	193.29746900455	105.85500276367	65.025678022713	66.025679022717
6 12020311370	Ahmad Yazid Zidan Akintop	110	340	390	0	590	585	75.30406459	1495 15,298052544	392 124.30515251024	15,29800,2544	CHIP Bak	371	390	388	85.322272845703	22.536878366597	131,88755931736	22.536878366597
7 12020511346	Alifian Newel Haq	390	390	390	o	396	205	65.81878386	1463 19.268266687	648 132,6774,5781766	19.269269687	648 Culup Bak	350	250	360	127.6217694366	35.811108165638	87.566225033436	35.811106163636
8 12120913732	Brillian Saputera Pratama M.	426	422	308	43.20788317 *	590	290	75.32913210	17041 14.99158686	245 124.65320591482	14.99138686	245 Cukup Baik	430	403	190	11.805820642505	64.640518234462	184.31125839229	33.005820541502
						390	3983	75.12913210	17541 54.99158686	245 134.66320591482	14.99158605	245 Cultury Balk	303	310	100	18756323690040	98,751284624411	35.020435846/923	20.0284000545000
Iterasi Ke 2						* 422	388	27.36739198	13992 56.389139188	558 171.88183301723	27.367391983	1012 Esk -	315	202	105	133.09353015067	45.144730726997	81.025871260394	46.1447307235991
CLUSTER	NILAI TAJWID		NILAI FASHOHAH		NILAI HAFALAN	000 100701							315	335	165	110.2540418282	57.001744570017	64.545423214528	57.9011640.00011
CI	431.96825396825		432,269841,26984		390.0535555556	Iterasi Ke 5													
C2	420.73134328358		417.94029650745		372.70149253731	CLUSTER		NILAI TAJWID		NILAI FASHOHAH	1	NILAI HARALAN							

0		333.81735159811		331.5461	1872145	1	171.17351590	174
N	IMA LENGKAP	NILAI 1	UWID NILAI FA	DIONAH NILAI P	IAFALAN	C1	c	
Achmad Sulton	Arrivuddin Kumal	* 39	0 BI	x) 3	90	59.5657360278	64 44.99237	825
Aft Dwi Airul V	aqin	19	0 21	0. 3	05.	59.6011671929	12 44,2(194	834
Ahmad Ack Sep	sutra	38	8 31	8 3	88	12.4279705878	6,92341	247)
Ahmad Daniel I	Mateen Vilala	39	0 31	0 3	85	59.0011671929	44.20194	834
Ahmad Misbah	us Sunni	39	6	6 3	85	51.1218347470	5 36.42883	1001
Ahmad Yazid Zi	idan Attintop	39	0 35	0 3	90	59,5657360278	54 44,99237	825
Althan Naveal H	pa	19	0 H	10 J	90	9.5657360270	44.99237	125
Brillian Saputer	a Pratema M.	42	6 43	2 1	91 10000	12.0546673027	16.68185	*
tellae Sepute terasi Ke 3 custor C1	a Pratema M.	42 NILAI TAJWID 444,1452901653	6 43	2 1 NICALFA 445.0540	SHOHAH	12.0546673027	21 16.68183 NELAI HARAL	102° *
tellae Sapute terasi Ke 3 custta C1 C2	a Postema M.	42 NILAI 14JWID 444(162291163) 396/50427350427	s 41	2 1 NILAI FA 445.0940 393.3070	SHOHAH 11703402 18230769	12.0546673027	21 16.68185 NELAL HAFAL IIII.65811965 376.41892341	192° * 112 112
Initian Separate Remasi Ke 3 Colomba Ci Ci Ci Ci	a Pratama M	42 NILAI TAJWID 444.1452991453 396.50427150427 322.28651465380	6 43	2 3 NILALIA 445.0940 393.3070 319.640	SHOHAH 1703402 1230769 6494332	12.0546673027	21 16.68185 NEAL HAAAA IBL65811965 376.41895041	192 * 112 112 137
Initian Supplementaria Construction Construc	a Pestama M.	42 NILAI TAJWID 444 165291163 395 50427150427 322 2005165330 NILAI (MANALAN	6 43 6	2 1 NILATTA 445.0940 393.3070 319.640 C2	анонан 11703402 8230769 6494342	12.0546673027	21 16.68185 NGLAI HARAL INE 65811965 375.41890941 INE 17415730 INE TERDEKAT	102 * 112 83 1137
Terilie Sopole Cerasi Ke 3 CLUSTER C1 C2 C3 AL 1AJWID No 310	a Postama M. IIZAI FASHIOHAH 390	42 NILAI TASWID 444.162291463 396.50427150427 322.28051665380 NILAI HANALAN 390	e 4: C1 77 256421541529	2 3 NILATEA 445.0940 393.3070 319.640 c2 15.417370164781	91 9100HAH 11793402 1230769 4494382 09.642582	12 05466710277 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	<ol> <li>16.681183</li> <li>108.65311965</li> <li>376.41895941</li> <li>178.17415730</li> <li>48.18805941</li> <li>17370164781</li> </ol>	102 AAN 112 83 337 C
Initial Sepure cerasi Ke 3 cuustes c1 c2 c3 c3 Al SAUMIO No 390	a Preterna M. III. Al FASHIOHAH 390 290	42 NILAI TASWID 444.162291463 396.50427150427 322.28051605380 NILAI HAJALAN 390 388	c1 77.255420540523 77.24957773719	2 3 NILATFA 445.0940 393.3070 319.640 c2 15.417370164781 13.6483155051177	98 99/09/404 11709/402 1230769 4494382 4494382 99.642582 99.642582	12.0546073027 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	21 16.68183 20140 HAMAN 20140 HAMAN 20140 HAMAN 2014 HA	102" * 1112 83 1117 0 0 0 0

310	390 390 77.25	0420540523 15.417	270164781 99.6425	0.2206074 15.4	17370164781 C	Ahmad Fahmy Khokdy		350	350	380	127.89493315452	38.4038550136
390	390 390 77.25	8428549523 15.417	370164781 99.642	A2266874 15-4	17370164281 C	Ahmad Imong Budione		430	426	390	34.035415300935	42,2514018501
426	422 398 29.31	7178695299 42.74	75451966 146.802	05728005 29.3	- 952636717	Ahmad Zaidan Salim		305	310	190	187.81083894304	99.3093153930
	Media (1980)	0125600000000000000000000000000000000000		000000000000000000000000000000000000000	100000	Aufil Ohulam		335	340	165	134.29731332885	48.0343288511
lterasi Ke 4						Dani Falzin		115	335	265	150:60135579318	60.441529474
CLUSTER	NILAI TAJWID		NILAI FASHOHAH	E C	ILAI HAJALAN		-		_	_		
61	443.248		643.248		388.056	Iterasi Ke 7						
C2	395.30179746835		381.48734177215		177,01265822785	Current		NE IN TA OMIT		NO. AL ADDRESS		
-	304.50387596899		302,25351589147		106.0202240362	(1		440		445 10/2022/62	0 1	87 31460902304
NO AL EXCLUSION		0		INTER TREDER	e cuerre la	0		378.0632183400		321.965517241	31 1	76.47701149425
202	200 75 12012100M	1 14.00158606245	124.05120501402	14 001110 0014	Coloradak	a		287.62886597938		290,731958762		63.72164949454
191	388 75 10404/59149	CREATESTING AND	134.35818251824	13.29655254429	Color Refe							
100	202 70 12249706246	7 11 000 45 36 7 2 3 3	121 53182965876	11 05845 247722	Color Bak	350	390	345 1	03.07297667735	34,430346876095	119.15148063196 3	4.430046874685
390	388 75 30205459149	13246552544290	174 3081 825 1024	12,28655254439	Colore Rely	350	270	370 1	93,29746900455	105.85500276367	66.025678022713	96.025679022711
104	100 00 01070100140	1 10 346/16467644	131-47141291206	10 36026668764	A. Color Bab	371	390	348 8	5.322272865703	22.536878366597	131.88755931736 2	12.534878384597
101	100 75 12011210/044	1 14 00158888345	124 44 1275 21482	14.0011040634	Color Ask	350	250	360 1	27.6217694366	35.011100105638	87.566225033436	15.811106105638
100	190 75.120132107054	1 14.00135606245	134.66120101482	14.0015860534	Culture Back	430	403	390 B	3.805820642505	64.640538234462	104.31125839229	13.405820643502
422	100 27 16710 100 100	5.5 100100188554	171 00102301723	77 3ATT0104100		903	310	300 1	87.56323692043	98.751384624401	35.5254556467993	00.9284000548095
	and the second se				1 ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) (	335	260	385 1	33.99353015267	45.144730726997	81.026873260394 4	46.3447307255991
Iterasi Ke 5						335	335	345 t	50,29405188282	57.001744670017	64.640423214528 1	\$7,901764870011
CLUSTER.	NILAI TAJWID		NILAI FASHOHAH		ILAI HAFALAN			A MARINA AND				-
C1	441.33582009552		441.71641791045		87.92537313433	Iterasi Ke 8						
.02	382.11904761905		376.85119047619		76.12738096238	CLUSTER		NEAL TAJWID		NILAI FASHOR		ILAI HAFALAN
a	294,43636363636		285.34545454545	1	65.45454545453	CI.	_	419,2955222222		4214175	1	17.3472222222
						a		375.97687061272		270.094210453	14 1	76.13294797688
405 11720502324	Sapta Dui Caliyana	350	390	165	105.0017922	a		286.05315709474		289.765421052	63 3	63.74736842305
406 12020710631	Vikri Aska Tutal	350	270	370	195.3204530							20000000000
407 11720302244	Zenul	371	390	386	87.30246933	390	385	102.18214558215	34,1701070579	45 120-4537062630	0 04.170107937945	S Cuikup Belk
408 11720502268	Ahmad Fahmy Kholidy	350	350	360	129.600164	270	370	782.35821917922	104.71482860.2	30 05.04414003083	9 06.0441403320885	Forang Balk
409 11720902259	Ahmad Imong Budiono	430	400	390	3563147132	390	388	84.394831631637	22.1098617558	36 123,2188510681	8 21.180861755096	5 Cukup Beik
410 11720503113	Ahmad Zaidan Salim	305	310	310	189.5810502	350	380	128.66752976984	34.4015018550	17 88.90182370087	2 34401501835011	7 Cukup Baik
411 11720902242	Audi Ghulam	535	360	365	1362531237	405	390	32,91861662063	66.1293804365	59 187,6522241529	8 32.91361662063	field
412 11820/01873	Datil faizin	135	325	365	152,3852794	310	390	186.61013813175	95.3583917353	12 37.87818906956	0 37,878109360560	) Karang Balk
-						360	345	133.07217877776	44,7981443198	85.26719823723	8 44736144319683	2 Cultup Bolk
Itarari Va 6						335	365	149.34885257229	56.4055380008	38 6621114048748	7 56,405538000638	E Cusup Bolk
terasi ite u				_				_			_	
CLUSHOR	NULLIGUNU	_	Relian Providences		ILA POSSILAN	Iterasi Ke 9						
0	100.0003716280		114 1114 1114		01.72031142031	QUETTR		NE AL TA OVID		NEL AL DASSION		III AI IIIAGAI AN
0	313.40479190479		363 606 (Dealers		44 460708330077	<i>a</i>		410.10210344828		439.2	1	87.29655172414
	2.0130132301032		a.m. 379 13394013	8	And the mail 22017			110 75400 172002		133 100513420		76 11040311478
Sapta Dei Caliyina	150	390	385	103.31 145699570	14.3366552001	a		266.05315709474		282.760473052	u 1	63.74736842305
Vikel Asker Todal	115	2.00	105	10110204401140	100 4440 4507							

Figure 8. K-Means Iteration Calculation Interface Display.

#### **Initial Centroid Determination** e)

ta Centroid Cluster P	usat Awal Untuk Metode K-Means				
ma Cluster	Balk				
	Cen	troid Pusat Awal Yang	Dipilih		
NUP	NAMA LENGKAP	NIL	U TAJWID NILAU	ASHORAH N	ILAI HAFALAN
12020311438	Achmad Sulton Amiruddin Kumala		390	390	290
	6	Pilih Centroid Pusat A	law		
NEUP	NAMA LENGKAP	Pilih Centroid Pusat A	NELAI FASHOHAH	NILAI HAFALAN	4 1910.04
NIUP 12020311438	NAMA LENGKAP Actenad Sulton Amiruddin Kuttala	Pilih Centroid Pusat A NRLAI TAJWID 300	WAI NELAI FASHOHAH 390	NILAI HAFALAN 390	e Piliti Piliti
NIUP 12020311438 12020711426	NAMA LENGKAP Actenia Sulton Amirudilin Kumula AHF Del Akual Yaqin	Pilih Centroid Pusat A NELAI TAJWID 310 310	NRI, AL FASHOHAH 390 370	NILAI HAFALAN 390 380	e PLH PHN Pin
NIUP 12020311438 12020711426 12020711253	NAMA LENGKAP Admus Guton Amirutilin Kumala AHP Dai Anul Yaqim Ahmud Adi Saputra	Plih Centroid Pusat A NELAI TAJWID 300 990 388	NAN ALAN PASHOMAN 390 388	NILAI MAFALAN 390 383 388	i Pilai Pila Pila Pila
NILUP 12020311438 12020711426 12020711253 12020511458	NAMAR LENGKAR Admust Gutan Anricuttin Kumata Aff Dei Anut Yagin Ahmad Adi Saputra Ahmad Adi Saputra	Plih Centroid Pusat A Net Al TAJWID 300 230 388 390	haw hishohan 390 292 388 392	NILAI HAFALAN 300 300 300 300 300 300	4 PLDI Plih Plih Plih Plih
NEUP 12020311438 12020711426 120207114253 12020511458 12020511458	HAMA ENGLAP Actimat Suttan Anricuttiin Kunata Aff Dei Ainu Ingm Ahmad Aki Saputra Ahmad Daviel Natieen Vola Ahmad Sistehius Sururi	Plih Centroid Pusat A Net Al TA-NVD 300 390 390 390 390 390	wal RICLAI FACSHOHAM 300 300 300 300 300 300 300	NILAI HAFALAN 300 308 308 308 308	* 2004 2906 2006 2006 2006

Figure 7. Initial Centroid Determination Interface Display.

### g) Clustering Results

Cluste	r Pertama (BAI	K)			
	17120212727	Proton Constant M	100	422	200
	12020111222	Michaelmad Scieff Haras (thaidflish			280
	12020111222	Rafa El Annal Tanas Mahamia	415	415	330
2	12020911469	Zulfi Zaimul Marza	420	410	315
	12020711344	Arhmad Firstaur Zalni	450	455	390
6	12020911450	Abmed Earban Eilah	415	420	290
4	12020311387	Salkil Johar Kumala	430	477	390
	12020511591	Ahmad Kevin Randika Gautama	435	430	387
Cluste	r Kedua (CUKU	P BAIK)			
NO	NUP	NAMA LENGKAP	NILAI TA/WID	NILAI FASHOHAH	NILAI HAFALAN
1.	12020311438	Achmad Sulton Amiruddis Kumala	390	390	390
2	12020711426	Afrif Dwi Ainul Yaqin	390	390	318
3	12020111253	Ahmad Adi Saputra	388	355	398
4	12020511450	Ahmad Daniel Mateen Wafa	390	390	388
5	12020511218	Ahmad Misbahus Sururi	396	396	288
6	12020311370	Ahmad Yazid Zidan Altintep	390	390	390
7	12020511346	Alifian Navial Hag	390	390	390
8	12020911776	Gilang Kumiawan Ramadhan	368	388	386
Cluste	r Ketiga (KURA	NG BAIK)			
NO	NUP	NAMA LENGKAP	NILAI TAJWID	NILAI FASHOHAH	NILAI HAFALAN
1	12020911212	Ratifiya Farrel Bayu Prasasta	315	319	284
2	12020910589	Vicky Sera Alfansyah	298	320	370
3	12020511282	Rilfat Spawqi	310	315	390
4	12020311116	Riski Septia Ramadani	300	3.20	380
8	12020310314	Robithurahman	320	265	385
6	12020311303	Ahmad Farel Alfarisi Oktavian	299	299	360
	12020111236	Ahmad Rakan Maulidi Sahirol Layali	299	299	390
7					

Figure 9. K-Means Iteration Calculation Interface Display.

### 3.4 Clustering Data Calculation

In this study, the clustering process was conducted based on the data related to Tajwid Score, Fashohah Score, and Memorization Score. After successfully processing the data, it was determined that the objects would be grouped into 3 clusters. The choice of k = 3 or c = 3 for clustering was driven by the analysis indicating that the data could be effectively categorized into three distinct groups. This decision was informed by the distribution and patterns observed in the scores, which suggested three identifiable clusters with varying levels of Tajwid proficiency, Fashohah clarity, and Memorization skills. By selecting k = 3, the study aimed to provide a meaningful segmentation of the data, enabling clearer insights into the relationships between the variables and facilitating a more insightful interpretation of the results. Thus, k = 3was pivotal in achieving a structured understanding of how these scores correlate and differ across the clustered groups. The following is the data clustering process for each calculation model.

### a) Determining Initial Cluster Centers

In the initial cluster, the cluster centers are randomly determined. In the first trial (Iteration 1), 3 d ata points are randomly selected as the initial center points for calculating the distance from all cluster groups to be formed.

Number of Clusters	= 3 (Good, Fairly Good,
	Less Good)
Number of Data	= 412 Data
Number of Variables	= 3 (Tajwid Score,
	Fashohah Score,
	Memorization Score)

Table 2. Initial Data of First Iteration Center

NIUP	NAME	Т	F	Н	CLUSTER
12020311438	Achmad Sulton Amiruddin K	390	390	390	C1
12020711426	Afif Dwi Ainul Yaqin	390	390	388	C2
12020111253	Ahmad Adi Saputra	388	388	388	C3

From Table 2, it can be seen that each data has a cluster center value.

C1	= (390	390	390)
C2	= (390	390	388)
C3	= (388	388	388)

### b) Calculation of Centroid Distances

In this phase, the distances between each data point and the cluster centers are determined using Euclidean Distance. The distance calculation from each data point to the first cluster center is outlined below:

For Cluster 1 (1):
$\sqrt{((390 - 390)^2 + (390 - 390)^2 + (390 - 390)^2)}$
For Cluster 2 (2):
$\sqrt{((390 - 390)^2 + (390 - 390)^2 + (388 - 390)^2)}$
For Cluster 3 (3):
$\sqrt{((388 - 390)^2 + (388 - 390)^2 + (388 - 390)^2)}$

This process continues for all data points and all clusters. After obtaining these distances in the first iteration, they are recorded in Table 3.

Table 3. Calculation Results in the First Iteration

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	0	2	3,464101615
2	Afif Dwi Ainul Yaqin	2	0	2,828427125
3	Ahmad Adi Saputra	3,464101615	2,828427125	0
410	Ahmad Zaidan Salim	116,7433082	113,9166362	113,9166362
411	Aufil Ghulam	66,73829485	64,20280368	64,20280368
412	Danil Faizin	81,11103501	78,40280607	78,40280607

Next, the second iteration involves calculating new centroid positions. This is achieved by finding the mean of the data within each cluster. The means for each attribute (Tajwid, Fashohah, and Hafalan) are computed and presented as the new centroids in Table 4.

Tuble 1. Thew Controlus in the Second Relation				
NEW CENTROIDS	Т	F	Н	
C1	431,968253968	432,269841269	390,055555555	
	254	841	556	
C2	420,731343283	417,940298507	372,701492537	
	582	463	313	
C3	333,817351598	331,146118721	371,173515981	
	174	461	735	

Table 4. New Centroids in the Second Iteration

are re-evaluated utilizing the Euclidean Distance method. This step replicates the methodology described in the initial iteration.

The second iteration commences with computing the Euclidean Distance between each data point and the updated centroids of every cluster. This procedure closely resembles the approach undertaken in the First Iteration.

After computing the new centroids, the distances from every data point to these centroids

For each data point, its distance to the first cluster center (C1) is computed as follows:

$$C1 (1) = \sqrt{((390 - 431,968253968254)^2 + (390 - 432,269841269841)^2 + (390 - 390,05555555556)^2)}$$

$$C1 (2) = \sqrt{((390 - 431,968253968254)^2 + (390 - 432,269841269841)^2 + (388 - 390,05555555556)^2)}$$

$$C1 (3) = \sqrt{((388 - 431,968253968254)^2 + (388 - 432,269841269841)^2 + (388 - 390,05555555556)^2)}$$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 420,731343283582)^2 + (390 - 417,940298507463)^2 + (390 - 372,701492537313)^2)}$$

$$C2 (2) = \sqrt{((390 - 420,731343283582)^2 + (390 - 417,940298507463)^2 + (388 - 372,701492537313)^2)}$$

$$C2 (3) = \sqrt{((388 - 420,731343283582)^2 + (388 - 417,940298507463)^2 + (388 - 372,701492537313)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

C3 (1)	=	$\sqrt{((390 - 333,817351598174)^2 + (390 - 331,146118721461)^2 + (390 - 371,173515981735)^2)}$
C3 (2)	=	$\sqrt{((390 - 333,817351598174)^2 + (390 - 331,146118721461)^2 + (388 - 371,173515981735)^2)}$
C3 (3)	=	$\sqrt{((388 - 333,817351598174)^2 + (388 - 331,146118721461)^2 + (388 - 371,173515981735)^2)}$

And so on until C3(412).

The results of these distance calculations are recorded in Table 5. Next, because the results of the Second Iteration are not the same as the First Iteration, the process continues with the Third Iteration. This process involves calculating the positions of the new centroids based on the average of the data in each cluster, as done in the First and Second Iterations.

Table 5. Calculation Results in the Second Iteration

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	59,56573603	44,99237826	83,51470424
2	Afif Dwi Ainul Yaqin	59,60116719	44,26194834	83,08670103
3	Ahmad Adi Saputra	62,42797059	46,92341248	80,31969726

410	Ahmad Zaidan Salim	176,2692676	159,1982733	40,39844787
411	Aufil Ghulam	123,5052756	103,7605628	29,53061838
412	Danil Faizin	139,6139146	119,533549	7,37315114

In the third iteration, to find the new centroids, the average value of the data grouped in the second iteration is taken. These new centroids are then recorded in Table 6.

Table 6. New Centroids in the Third Iteration

NEW CENTROIDS	Т	F	Н
C1	444,145299145 299	445,094017094 017	388,658119658 12
C2	396,504273504 274	393,307692307 692	376,418803418 803
C3	322,286516853 933	319,640449438 202	370,174157303 371

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1) = 
$$\sqrt{((390 - 444, 145299145299)^2 + (390 - 445, 094017094017)^2 + (390 - 388, 65811965812)^2)}$$
  
C1 (2) =  $\sqrt{((390 - 444, 145299145299)^2 + (390 - 445, 094017094017)^2 + (388 - 388, 65811965812)^2)}$ 

$$C1 (3) = \sqrt{((388 - 444, 145299145299)^2 + (388 - 445, 094017094017)^2 + (388 - 388, 65811965812)^2)}$$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 396,504273504274)^2 + (390 - 393,307692307692)^2 + (390 - 376,418803418803)^2)}$$

$$C2 (2) = \sqrt{((390 - 396,504273504274)^2 + (390 - 393,307692307692)^2 + (388 - 376,418803418803)^2)}$$

$$C2 (3) = \sqrt{((388 - 396,504273504274)^2 + (388 - 393,307692307692)^2 + (388 - 376,418803418803)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

C3 (1)	=	$\sqrt{((390 - 322,286516853933)^2 + (390 - 319,640449438202)^2 + (390 - 370,174157303371)^2)}$
C3 (2)	=	$\sqrt{((390 - 322,286516853933)^2 + (390 - 319,640449438202)^2 + (388 - 370,174157303371)^2)}$
C3 (3)	=	$\sqrt{((388 - 322, 286516853933)^2 + (388 - 319, 640449438202)^2 + (388 - 370, 174157303371)^2)}$

And so on until C3(412).

From these calculations in the third iteration, the distances from each data point to each cluster are obtained as listed in Table 7.

Table 7. Calculation Results in the Third Relation				
NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	77,25842855	15,41737016	99,64259227
2	Afif Dwi Ainul Yaqin	77,24957774	13,68833505	99,26400568
3	Ahmad Adi Saputra	80,07780295	15,31725758	96,48342183
410	Ahmad Zaidan Salim	193,942281	124,4895681	28,01474556
411	Aufil Ghulam	140,404397	70,87007195	42,62977691
412	Danil Faizin	156,8218593	85,51579803	20,59903762

Table 7. Calculation Results in the Third Iteration

Next, because the result of the third iteration differs from the second iteration, the process continues with the fourth iteration. The positions of the new centroids in the fourth iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration.

In the fourth iteration, to find the new centroids, the average value of the data grouped in the third iteration is taken. These new centroids are then recorded in Table 8.

Table 8. New Centroids in the Fourth iteration					
NEW CENTROIDS	Т	F	Н		
Cl	443,248	443,248	388,056		
C2	386,303797468 354	383,487341772 152	377,012658227 848		
C3	304,503875968 992	302,263565891 473	366,899224806 202		

Table 8. New Centroids in the Fourth Iteration

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration.

This iteration begins with computing the Euclidean Distance between each data point and the

newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1) = 
$$\sqrt{((390 - 443,248)^2 + (390 - 443,248)^2 + (390 - 388,056)^2)}$$

C1 (2) = 
$$\sqrt{((390 - 443,248)^2 + (390 - 443,248)^2 + (388 - 388,056)^2)}$$

C1 (3) = 
$$\sqrt{((388 - 443,248)^2 + (388 - 443,248)^2 + (388 - 388,056)^2)}$$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 386,303797468354)^2 + (390 - 383,487341772152)^2 + (390 - 377,012658227848)^2)}$$

$$C2 (2) = \sqrt{((390 - 386,303797468354)^2 + (390 - 383,487341772152)^2 + (388 - 377,012658227848)^2)}$$

$$C2 (3) = \sqrt{((388 - 386,303797468354)^2 + (388 - 383,487341772152)^2 + (388 - 377,012658227848)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

$$C3 (1) = \sqrt{((390 - 304,503875968992)^2 + (390 - 302,263565891473)^2 + (390 - 366,899224806202)^2)}$$

$$C3 (2) = \sqrt{((390 - 304,503875968992)^2 + (390 - 302,263565891473)^2 + (388 - 366,899224806202)^2)}$$

$$C3 (3) = \sqrt{((388 - 304,503875968992)^2 + (388 - 302,263565891473)^2 + (388 - 366,899224806202)^2)}$$

And so on until C3(412).

From these calculations in the fourth iteration, the distances from each data point to each cluster are obtained as listed in Table 9.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	75,32913211	14,99158686	124,6632059
2	Afif Dwi Ainul Yaqin	75,30406459	13,29655254	124,3081325
3	Ahmad Adi Saputra	78,13249096	11,99845267	121,5219387
410	Ahmad Zaidan Salim	192,0190567	110,3601737	24,36687026
411	Aufil Ghulam	138,4898485	57,68915683	65,32316939
412	Danil Faizin	154,8122674	71,60590691	44,78051757

Table 9. Calculation Results in the Fourth Iteration

Furthermore, since the results of the fourth iteration differ from the third iteration, the process continues with the fifth iteration. The positions of the new centroids in the fifth iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration. In the fifth iteration, to find the new centroids, the average value of the data grouped in the fourth iteration is taken. These new centroids are then recorded in Table 10.

NEW CENTROIDS	Т	F	Н
Cl	441,335820895	441,716417910	387,925373134
	522	448	328
C2	382,119047619	376,851190476	376,327380952
	048	191	381
C3	294,436363636	295,345454545	365,454545454
	364	455	545

Table 10. New Centroids in the Fifth Iteration

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

$$C1 (1) = \sqrt{((390 - 441,335820895522)^2 + (390 - 441,716417910448)^2 + (390 - 387,925373134328)^2)}$$

$$C1 (2) = \sqrt{((390 - 441,335820895522)^2 + (390 - 441,716417910448)^2 + (388 - 387,925373134328)^2)}$$

$$C1 (3) = \sqrt{((388 - 441,335820895522)^2 + (388 - 441,716417910448)^2 + (388 - 387,925373134328)^2)}$$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 382,119047619048)^2 + (390 - 376,851190476191)^2 + (390 - 376,327380952381)^2)}$$

$$C2 (2) = \sqrt{((390 - 382,119047619048)^2 + (390 - 376,851190476191)^2 + (388 - 376,327380952381)^2)}$$

$$C2 (3) = \sqrt{((388 - 382,119047619048)^2 + (388 - 376,851190476191)^2 + (388 - 376,327380952381)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

$$C3 (1) = \sqrt{((390 - 294,436363636364)^2 + (390 - 295,345454545455)^2 + (390 - 365,45454545454545)^2)}$$

$$C3 (2) = \sqrt{((390 - 294,436363636364)^2 + (390 - 295,345454545455)^2 + (388 - 365,45454545454545)^2)}$$

$$C3 (3) = \sqrt{((388 - 294,436363636364)^2 + (388 - 295,345454545455)^2 + (388 - 365,45454545454545)^2)}$$

And so on until C3(412).

From these calculations in the fifth iteration, the distances from each data point to each cluster are obtained as listed in Table 11.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	72,89896066	20,54120527	136,7273598
2	Afif Dwi Ainul Yaqin	72,86947206	19,26786542	136,3825102
3	Ahmad Adi Saputra	75,69787918	17,17939435	133,5938485
410	Ahmad Zaidan Salim	189,581051	102,9726647	30,47663785
411	Aufil Ghulam	136,0531238	51,30766832	76,32709515
412	Danil Faizin	152,3852794	64,03152624	56,72828379

Table 11. Calculation Results in the Fifth Itera	tion
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Furthermore, since the results of the fifth iteration differ from the fourth iteration, the process continues with the sixth iteration. The positions of the new centroids in the sixth iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration.

In the sixth iteration, to find the new centroids, the average value of the data grouped in the fifth iteration is taken. These new centroids are then recorded in Table 12.

NEW CENTROIDS	Т	F	Н
C1	440,142857142 857	440,4	387,728571428 571
C2	379,404761904	374,422619047	376,2916666666
	762	619	667
C3	291,951923076	292,596153846	364,480769230
	923	154	769

Table 12. New Centroids in the Sixth Iteration

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1) = 
$$\sqrt{((390 - 440, 142857142857)^2 + (390 - 440, 4)^2 + (390 - 387, 728571428571)^2)}$$

$$C1 (2) = \sqrt{((390 - 440, 142857142857)^2 + (390 - 440, 4)^2 + (388 - 387, 728571428571)^2)}$$

$$C1(3) = \sqrt{((388 - 440, 142857142857)^2 + (388 - 440, 4)^2 + (388 - 387, 728571428571)^2)}$$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 379,404761904762)^2 + (390 - 374,422619047619)^2 + (390 - 376,2916666666667)^2)}$$

$$C2 (2) = \sqrt{((390 - 379,404761904762)^2 + (390 - 374,422619047619)^2 + (388 - 376,2916666666667)^2)}$$

$$C2 (3) = \sqrt{((388 - 379,404761904762)^2 + (388 - 374,422619047619)^2 + (388 - 376,2916666666667)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

C3 (1)	=	$\sqrt{((390 - 291,951923076923)^2 + (390 - 292,596153846154)^2 + (390 - 364,480769230769)^2)}$
C3 (2)	=	$\sqrt{((390 - 291,951923076923)^2 + (390 - 292,596153846154)^2 + (388 - 364,480769230769)^2)}$
C3 (3)	=	$\sqrt{((388 - 291,951923076923)^2 + (388 - 292,596153846154)^2 + (388 - 364,480769230769)^2)}$

And so on until C3(412).

From these calculations in the sixth iteration, the distances from each data point to each cluster are obtained as listed in Table 13.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	71,13104463	23,29876113	140,5423985
2	Afif Dwi Ainul Yaqin	71,09528673	22,18104905	140,1930414
3	Ahmad Adi Saputra	73,92368514	19,88236558	137,4055354
410	Ahmad Zaidan Salim	187,8108389	99,36931539	33,53173588
411	Aufil Ghulam	134,2973133	48,03432685	79,97927859
412	Danil Faizin	150,6013558	60,44358947	60,42758225

Table 13. Calculation Results in the Sixth Iteration

Furthermore, since the results of the sixth iteration differ from the fifth iteration, the process continues with the seventh iteration. The positions of the new centroids in the seventh iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration.

In the seventh iteration, to find the new centroids, the average value of the data grouped in the sixth iteration is taken. These new centroids are then recorded in Table 14.

NEW CENTROIDS T		F	Н
CI	440	440,184397163 121	387,354609929 078
C2	378,063218390 805	371,965517241 379	376,477011494 253
C3	287,628865979 381	290,731958762 887	363,721649484 536

Table 14. New Centroids in the Seventh Iteration

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1)	=	$\sqrt{((390 - 440)^2 + (390 - 440, 184397163121)^2 + (390 - 387, 354609929078)^2)}$
C1 (2)	=	$\sqrt{((390 - 440)^2 + (390 - 440,184397163121)^2 + (388 - 387,354609929078)^2)}$

$$C1(3) = \sqrt{((388 - 440)^2 + (388 - 440, 184397163121)^2 + (388 - 387, 354609929078)^2)}$$

### And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 378,063218390805)^2 + (390 - 371,965517241379)^2 + (390 - 376,477011494253)^2)}$$

$$C2 (2) = \sqrt{((390 - 378,063218390805)^2 + (390 - 371,965517241379)^2 + (388 - 376,477011494253)^2)}$$

$$C2 (3) = \sqrt{((388 - 378,063218390805)^2 + (388 - 371,965517241379)^2 + (388 - 376,477011494253)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

$$C3 (1) = \sqrt{((390 - 287,628865979381)^2 + (390 - 290,731958762887)^2 + (390 - 363,721649484536)^2)}$$

$$C3 (2) = \sqrt{((390 - 287,628865979381)^2 + (390 - 290,731958762887)^2 + (388 - 363,721649484536)^2)}$$

$$C3 (3) = \sqrt{((388 - 287,628865979381)^2 + (388 - 290,731958762887)^2 + (388 - 363,721649484536)^2)}$$

And so on until C3(412).

From these calculations in the seventh iteration, the distances from each data point to each cluster are obtained as listed in Table 15.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	70,89056219	25,50687244	144,9984303
2	Afif Dwi Ainul Yaqin	70,84412641	24,50527673	144,6493394
3	Ahmad Adi Saputra	73,67243606	22,10483047	141,8621679
410	Ahmad Zaidan Salim	187,5632569	96,75138462	36,92648665
411	Aufil Ghulam	133,9935302	46,14473073	83,92687326
412	Danil Faizin	150,2946639	57,90174467	64,84842321

Table 15. Calculation Results in the Seventh Iteration

Furthermore, since the results of the seventh iteration differ from the sixth iteration, the process continues with the eighth iteration. The positions of the new centroids in the eighth iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration.

In the eighth iteration, to find the new centroids, the average value of the data grouped in the seventh iteration is taken. These new centroids are then recorded in Table 16.

Table 16. New Centroids in the Eighth Iterati	on
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NEW CENTROIDS	Т	F	Н
Cl	439,395833333 333	439,4375	387,347222222 222
C2	376,976878612	370,994219653	376,132947976
	717	179	879
C3	286,663157894	289,768421052	363,747368421
	737	632	053

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1) = 
$$\sqrt{((390 - 439,3958333333)^2 + (390 - 439,4375)^2 + (390 - 387,34722222222)^2)}$$
  
C1 (2) =  $\sqrt{((390 - 439,3958333333)^2 + (390 - 439,4375)^2 + (388 - 387,34722222222)^2)}$   
C1 (3) =  $\sqrt{((388 - 439,3958333333)^2 + (388 - 439,4375)^2 + (388 - 387,34722222222)^2)}$ 

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 376,976878612717)^2 + (390 - 370,994219653179)^2 + (390 - 376,132947976879)^2)}$$

$$C2 (2) = \sqrt{((390 - 376,976878612717)^2 + (390 - 370,994219653179)^2 + (388 - 376,132947976879)^2)}$$

$$C2(3) = \sqrt{((388 - 376,976878612717)^2 + (388 - 370,994219653179)^2 + (388 - 376,132947976879)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

$$C3 (1) = \sqrt{((390 - 286,663157894737)^2 + (390 - 289,768421052632)^2 + (390 - 363,747368421053)^2)}$$

$$C3 (2) = \sqrt{((390 - 286,663157894737)^2 + (390 - 289,768421052632)^2 + (388 - 363,747368421053)^2)}$$

$$C3 (3) = \sqrt{((388 - 286,663157894737)^2 + (388 - 289,768421052632)^2 + (388 - 363,747368421053)^2)}$$

And so on until C3(412).

From these calculations in the eighth iteration, the distances from each data point to each cluster are obtained as listed in Table 17.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	69,93605642	26,89082574	146,3354811
2	Afif Dwi Ainul Yaqin	69,88877503	25,91617836	145,9899397
3	Ahmad Adi Saputra	72,71708334	23,48473321	143,2019162
410	Ahmad Zaidan Salim	186,6101381	95,35859174	37,87818937
411	Aufil Ghulam	133,0721788	44,79814432	85,26719224
412	Danil Faizin	149,3488526	56,405538	66,21114049

Table 17. Calculation Results in the Eighth Iteration

Furthermore, since the results of the eighth iteration differ from the seventh iteration, the process continues with the ninth iteration. The positions of the new centroids in the ninth iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration.

In the ninth iteration, to find the new centroids, the average value of the data grouped in the eighth iteration is taken. These new centroids are then recorded in Table 18.

Table 16. New Centrolds in the Tunth Relation								
NEW CENTROIDS	Т	F	Н					
C1 439,193103448 276		439,2	387,296551724 138					
C2	376,784883720 93	370,796511627 907	376,110465116 279					
C3	286,663157894 737	289,768421052 632	363,747368421 053					

Table 18. New Centroids in the Ninth Iteration

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1)	=	$\sqrt{((390 - 439, 193103448276)^2 + (390 - 439, 2)^2 + (390 - 387, 296551724138)^2)}$
C1 (2)	=	$\sqrt{((390 - 439, 193103448276)^2 + (390 - 439, 2)^2 + (388 - 387, 296551724138)^2)}$
C1 (3)	=	$\sqrt{((388 - 439, 193103448276)^2 + (388 - 439, 2)^2 + (388 - 387, 296551724138)^2)}$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

C2 (1) = 
$$\sqrt{((390 - 376,78488372093)^2 + (390 - 370,796511627907)^2 + (390 - 376,110465116279)^2)}$$
  
C2 (2) =  $\sqrt{((390 - 376,78488372093)^2 + (390 - 370,796511627907)^2 + (388 - 376,110465116279)^2)}$ 

C2 (3) = 
$$\sqrt{((388 - 376, 78488372093)^2 + (388 - 370, 796511627907)^2 + (388 - 376, 110465116279)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

C3 (1)	=	$\sqrt{((390 - 286, 663157894737)^2 + (390 - 289, 768421052632)^2 + (390 - 363, 747368421053)^2)}$
C3 (2)	=	$\sqrt{((390 - 286,663157894737)^2 + (390 - 289,768421052632)^2 + (388 - 363,747368421053)^2)}$
C3 (3)	=	$\sqrt{((388 - 286, 663157894737)^2 + (388 - 289, 768421052632)^2 + (388 - 363, 747368421053)^2)}$

And so on until C3(412).

From these calculations in the ninth iteration, the distances from each data point to each cluster are obtained as listed in Table 19.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	69,62693487	27,13544625	146,3354811
2	Afif Dwi Ainul Yaqin	69,57798694	26,16819259	145,9899397
3	Ahmad Adi Saputra	72,40627514	23,72972577	143,2019162
410	Ahmad Zaidan Salim	186,3001279	95,09050708	37,87818937
411	Aufil Ghulam	132,7628676	44,56437597	85,26719224
412	Danil Faizin	149,0334829	56,13206915	66,21114049

Table 19. Calculation Results in the Ninth Iteration

Furthermore, since the results of the ninth iteration differ from the eighth iteration, the process continues with the tenth iteration. The positions of the new centroids in the tenth iteration are calculated by taking the average of the data included in each group or centroid as in the previous iteration.

In the tenth iteration, to find the new centroids, the average value of the data grouped in the ninth iteration is taken. These new centroids are then recorded in Table 20.

NEW CENTROIDS	Т	F	Н
Cl	439,082191780	438,863013698	387,315068493
	822	63	151
C2	376,514619883	370,684210526	376,029239766
	041	316	082
C3	286,663157894	289,768421052	363,747368421
	737	632	053

Table 20. New Centroids in the Tenth Iteration

After computing the new centroids, the distances from every data point to these centroids are reevaluated utilizing the Euclidean Distance method. This step repeats the methodology outlined in the previous iteration. This iteration begins with computing the Euclidean Distance between each data point and the newest centroids of each cluster. This procedure is similar to the approach taken in the previous iteration.

For each data point, its distance to the first cluster center (C1) is computed as follows:

C1 (1)	=	$\sqrt{((390 - 439, 193103448276)^2 + (390 - 439, 2)^2 + (390 - 387, 296551724138)^2)}$
C1 (2)	=	$\sqrt{((390 - 439,193103448276)^2 + (390 - 439,2)^2 + (388 - 387,296551724138)^2)}$
C1 (3)	=	$\sqrt{((388 - 439, 193103448276)^2 + (388 - 439, 2)^2 + (388 - 387, 296551724138)^2)}$

And so on until C1(412).

Then, the distance from each data to the second cluster center (C2) is computed using a similar formula:

$$C2 (1) = \sqrt{((390 - 376,78488372093)^2 + (390 - 370,796511627907)^2 + (390 - 376,110465116279)^2)}$$

$$C2 (2) = \sqrt{((390 - 376,78488372093)^2 + (390 - 370,796511627907)^2 + (388 - 376,110465116279)^2)}$$

$$C2 (3) = \sqrt{((388 - 376,78488372093)^2 + (388 - 370,796511627907)^2 + (388 - 376,110465116279)^2)}$$

And so on until C2(412).

Finally, the distance from each data to the third cluster center (C3) is calculated as follows:

$$C3 (1) = \sqrt{((390 - 286,663157894737)^2 + (390 - 289,768421052632)^2 + (390 - 363,747368421053)^2)}$$

$$C3 (2) = \sqrt{((390 - 286,663157894737)^2 + (390 - 289,768421052632)^2 + (388 - 363,747368421053)^2)}$$

$$C3 (3) = \sqrt{((388 - 286,663157894737)^2 + (388 - 289,768421052632)^2 + (388 - 363,747368421053)^2)}$$

And so on until C3(412).

From these calculations in the tenth iteration, the distances from each data point to each cluster are obtained as listed in Table 21.

NO	NAME	C1	C2	C3
1	Achmad Sulton Amiruddin K	69,30991643	27,38863526	146,3354811
2	Afif Dwi Ainul Yaqin	69,26127915	26,4245019	145,9899397
3	Ahmad Adi Saputra	72,08956659	23,98019229	143,2019162
410	Ahmad Zaidan Salim	185,9863417	94,82666506	37,87818937
411	Aufil Ghulam	132,4780731	44,26353068	85,26719224
412	Danil Faizin	148,7232011	55,84326884	66,21114049

Table 21. Calculation Results in the Tenth Iteration

Furthermore, since the results of the tenth iteration are the same as the ninth iteration, it is not necessary to perform calculations for the eleventh iteration, or it is sufficient to stop at the tenth iteration.

### c) Nearest Neighbor Search

In this stage, the search for the minimum distance is performed on the values of each cluster result. For example, in the first data, if the smallest value among the 3 clusters is C1, then the first data belongs to the C1 group. If the smallest value among the 3 clusters is C2, then the first data belongs to the C2 group. If the smallest value among the 3 clusters is C3, then the first data belongs to the C3 group. Please refer to the following table:

Table 22. Results of Nearest Neighbor Search and Cluster Group in the First Iteration

in the Thist Relation						
NAME	C1	C2	C3	JARAK TERDEKAT	CLUSTER	
Achmad Sulton Amiruddin K	0	2	3,4641 01615	0	C1	
Afif Dwi Ainul Yaqin	2	0	2,8284 27125	0	C2	
Ahmad Adi Saputra	3,4641 01615	2,8284 27125	0	0	C3	
Ahmad Zaidan Salim	116,72 61753	116,74 33082	113,91 66362	113,9166362	C3	

Aufil Ghulam	67,453 68782	66,738 29485	64,202 80368	64,20280368	C3
Danil Faizin	81,700 67319	81,111 03501	78,402 80607	78,40280607	C3

In the first iteration, the number of grouped data in each cluster was as follows: C1 had 126 grouped data, C2 had 67 grouped data, and C3 had 219 grouped data. In the second iteration, the numbers changed to: C1 with 117 grouped data, C2 with 117 grouped data, and C3 with 178 grouped. Please refer to the following table:

Table 23. Results of Nearest Distance Search and Cluster Groups in the Second Iteration

NAME	C1	C2	C3	JARAK TERDEKAT	CLUSTER
Achmad Sulton Amiruddin K	59,565 73603	44,992 37826	83,514 70424	44,99237826	C2
Afif Dwi Ainul Yaqin	59,601 16719	44,261 94834	83,086 70103	44,26194834	C2
Ahmad Adi Saputra	62,427 97059	46,923 41248	80,319 69726	46,92341248	C2
Ahmad Zaidan Salim	176,26 92676	159,19 82733	40,398 44787	40,39844787	C3
Aufil Ghulam	123,50 52756	103,76 05628	29,530 61838	29,53061838	C3
Danil Faizin	139,61 39146	119,53 3549	7,3731 5114	7,37315114	C3

Since the number of grouped data in each cluster in the second iteration differed from the first iteration, a search for the nearest distance (minimum) was conducted for each cluster's results in the third iteration. The results were: C1 with 125 grouped data, C2 with 158 grouped data, and C3 with 129 grouped data. Please refer to the following table:

Table 24. Results of Nearest Distance Search and Cluster Groups in the Third Iteration

NAMA	C1	C2	C3	JARAK TERDEKAT	CLUSTER
Achmad Sulton Amiruddin K	77,258 42855	15,417 37016	99,642 59227	15,41737016	C2
Afif Dwi Ainul Yaqin	77,249 57774	13,688 33505	99,264 00568	13,68833505	C2
Ahmad Adi Saputra	80,077 80295	15,317 25758	96,483 42183	15,31725758	C2

Ahmad Zaidan Salim	193,94 2281	124,48 95681	28,014 74556	28,01474556	C3
Aufil Ghulam	140,40 4397	70,870 07195	42,629 77691	42,62977691	C3
Danil Faizin	156,82 18593	85,515 79803	20,599 03762	20,59903762	C3

This iterative process continued through the fourth, fifth, sixth iterations, and so on, where the number of grouped data in each cluster could change in each iteration. This demonstrates an iterative process in finding the optimal clusters.

Finally, in the tenth iteration, the number of grouped data in each cluster remained the same as in the ninth iteration, concluding the iterative process with the following results: C1 with 146 grouped data, C2 with 171 grouped data, and C3 with 95 grouped data. Please refer to the following table:

Table 25. Results of Nearest Distance Search and Cluster Groups in the Tenth Iteration

NAME	C1	C2	C3	JARAK TERDEKAT	CLUSTER
Achmad Sulton Amiruddin K	69,309 91643	27,388 63526	146,33 54811	27,38863526	C2
Afif Dwi Ainul Yaqin	69,261 27915	26,424 5019	145,98 99397	26,4245019	C2
Ahmad Adi Saputra	72,089 56659	23,980 19229	143,20 19162	23,98019229	C2
Ahmad Zaidan Salim	185,98 63417	94,826 66506	37,878 18937	37,87818937	C3
Aufil Ghulam	132,47 80731	44,263 53068	85,267 19224	44,26353068	C2
Danil Faizin	148,72 32011	55,843 26884	66,211 14049	55,84326884	C2

### 3.5 Evaluation of Clustering Results

The clustering process for the Al-Qur'an learning groups using the k-means algorithm resulted in an appropriate number of grouped data in each cluster after the tenth iteration. From the calculation of 412 students' data, the following groups were formed:

- a) The first cluster (C1), representing the group with a good rating, consists of 146 students.
- b) The second cluster (C2), representing the group with a fairly good rating, consists of 171 students.
- c) The third cluster (C3), representing the group with a poor rating, consists of 95 students.

Table 26.	First	Cluster	Group	(Good)	)

NO			VALUE	CLUSTER	
NO	NAME	Т	F	Н	CLUSTER
1	Brillian Saputera Pratama M.	426	422	388	C1
2	Muhammad Syarif Hasan Ubaidillah	432	424	390	C1
3	Rafa El Asyraf Tegar Maharaja	435	435	390	C1
4	Zulfi Zaimul Mazza	420	410	335	C1
5	Achmad Firdaus Zaini	450	455	390	C1
6	Ahmad Farhan Billah	415	420	390	C1

7	Saiful Akbar Kumala	430	427	390	C1
8	Ahmad Kevin Randika Gautama	435	430	387	C1
9	Ahmad Sofiyan Hidayatullah	448	445	390	C1
10	Saiful Anwar Fatahillah	440	430	390	C1
145	Mochammad Rizal Rofiqi	425	415	385	C1
146	Ahmad Imong Budiono	430	408	390	C1

Table 27. Second Cluster Group (Fairly Good)

NO	NAME		VALUE	CLUSTER	
NO		Т	F	Н	CLUSTER
1	Achmad Sulton Amiruddin K	390	390	388	C2
2	Afif Dwi Ainul Yaqin	390	390	390	C2
3	Ahmad Adi Saputra	388	388	388	C2
4	Ahmad Daniel Mateen Wafa	390	390	388	C2
5	Ahmad Misbahus Sururi	396	396	388	C2
6	Ahmad Yazid Zidan Altintop	390	390	390	C2
7	Alifian Nawal Haq	390	390	390	C2
8	Gilang Kurniawan Ramadhan	388	388	386	C2
9	Habil Michael Jibril	390	392	388	C2
10	M Farih Romadhoni	390	390	390	C2
170	Aufil Ghulam	335	360	365	C2
171	Danil Faizin	335	335	365	C2

Table 32. Third Cluster Group (Poor)

NO	NAME	VALUE			CLUCTED
NO		Т	F	Н	CLUSTER
1	Raditya Farrel Bayu Prasasta	315	319	284	C3
2	Vicky Fiera Alfiansyah	298	320	370	C3
3	Rif'at Syawqi	310	315	390	C3
4	Riski Septia Ramadani	300	320	380	C3
5	Robithurrahman	320	265	385	C3
6	Ahmad Farel Alfarisi Oktavian	299	299	380	C3
7	Ahmad Rakan Maulidi Sahirol Layali	299	299	390	C3
8	M. Kayyas Dhia El Haq	325	325	378	C3
9	Mochammad Iqbal Matlubi	325	325	390	C3
10	Mohammad Rizal	325	325	390	C3
94	Vikri Aska Tufail	350	270	370	C3
95	Ahmad Zaidan Salim	305	310	390	C3

### 4. DISCUSSION

This study successfully developed a web-based application system using the K-Means algorithm to group students in the Qur'an learning activities at Nurul Jadid Islamic Boarding School, Paiton Probolinggo. The results show that the use of the K-Means algorithm is effective in clustering students, thus improving efficiency and accuracy in the learning process. In this section, the authors will further discuss the findings of this study, compare them with similar research, and provide interpretation and implications of the results obtained.

One of the main findings of this study is the effectiveness of the K-Means algorithm in grouping students based on their Qur'anic reading abilities, including fluency in Tajwid and memorization scores. This algorithm successfully clustered students into three skill categories: "Good," "Fair," and "Poor." This clustering provides an objective and accurate guide in determining the appropriate learning groups for each student. These results are consistent with the research conducted by Achmad Dimyati (2023), which also found that the K-Means algorithm was effective in evaluating academic scores of students at TPQ Darussalamah. The table below compares the results of this study with several similar studies:

Table 55. Comparison of Research Results.					
STUDY	CONTEXT	METHOD	MAIN FINDINGS		
This study	Grouping students based on Qur'an abilities at Nurul Jadid Islamic Boarding School	K-Means	Effective in clustering students into three skill categories: "Good," "Fair," and "Poor."		
Achmad Dimyati (2023)	Evaluating academic scores of students at TPQ Darussalamah	K-Means	The K-Means algorithm is effective in clustering students based on academic scores. These findings support our study's conclusion that K-Means can be used for educational classification.		
Ai Rohmah, Falentino Sembiring, and Adhitia Erfina (2021)	Classifying levels of learning obstacles in distance learning during the COVID-19 pandemic	K-Means	The K-Means algorithm helps identify levels of learning obstacles faced by students. This study highlights the flexibility of K-Means in various educational contexts, similar to our research.		
Dian Permata Sari (2021)	Determining the spread levels of the COVID-19 pandemic in West Sumatra	K-Means	The K-Means algorithm is effective in clustering regions based on positive cases and virus spread. This study shows that K-Means can be used in epidemiological data analysis, which is different from educational contexts but demonstrates the algorithm's flexibility.		

Table 33. Comparison of Research Results.

The implementation of technology and data analysis methods in this study aims to address the challenges faced by Nurul Jadid Islamic Boarding School. By leveraging technology, the clustering process becomes faster, more accurate, and more objective, thus increasing student motivation through personalized and tailored learning experiences. This study shows that with proper clustering, students can receive training that matches their abilities, which in turn improves learning outcomes.

The development of this web-based system also facilitates access and use by administrators and participants. This system not only benefits Nurul Jadid Islamic Boarding School but also has the potential to be applied in other Islamic educational institutions. With this system, the Qur'an learning process can be conducted more efficiently, allowing teachers to focus more on teaching rather than administrative tasks.

Although the results of this study demonstrate success in clustering students, several limitations should be noted. First, this study only used data from one institution, so the results may not be generalizable to other institutions without further adjustments. Second, this system relies on the quality of the input data; therefore, it is important to ensure that the data used is accurate and complete.

For future research, it is recommended to test this system in various Islamic educational institutions

with different characteristics to validate its reliability. Additionally, integrating more advanced automatic assessment systems can further enhance the accuracy of clustering.

# 5. CONCLUSION

This study demonstrates that the use of the K-Means algorithm is highly effective in grouping students based on their ability to read the Al-Qur'an. The research analyzed 412 students' data, evaluated in terms of tajwid (pronunciation), fashohah (fluency), and memorization. This data was then processed and clustered using the K-Means algorithm.

The results show that students can be categorized into three levels of proficiency: "Good", "Fairly Good", and "Poor". These categories provide clear guidance for determining the appropriate training group for each student, ultimately enhancing the efficiency and accuracy of the training process in accordance with the established curriculum.

This clustering method enables more precise training by grouping students based on similarities in their Al-Qur'an reading abilities. The use of webbased technology also facilitates easy access and utilization of the system by administrators, making the process faster, more accurate, and objective.

Overall, this study not only addresses the challenges faced by Pondok Pesantren Nurul Jadid in

organizing Al-Qur'an training groups but also contributes to the development of a more responsive and efficient training system for similar institutions in the future.

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