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# Optimizing Zakat Distribution with GIS and Data Mining in Community Empowerment at BAZNAS Deli Serdang

**Sinta Dara Efita[1], Triase[2]**

[1,2]Information System, State Islamic University of North Sumatra, Medan, Indonesia
Email: [1]sintadaeraefita3@gmail.com, [2]triase@uinsu.ac.id

**Abstract**

This research aims to develop an information system that utilizes Geographic Information System technology to map and analyze the distribution of zakat effectively in Deli Serdang Regency. The methods used include collecting data on zakat recipients and applying the K-means grouping method to identify distribution patterns in 22 districts. The results of the study show that there are three groups of zakat recipients: High Recipients, Medium Recipients, and Low Recipients. Tanjung Morawa was identified as the district with the highest number of zakat recipients, namely 239 people, which shows a significant need. The K-Means algorithm plays an important role in identifying areas that need help, so this Geographic Information System-based grouping is proven to improve the efficiency of zakat resource allocation. This allows BAZNAS to target assistance more precisely and strategically. This study recommends the use of this approach to optimize zakat management and support community economic empowerment, as well as reduce social inequality in the region.

**Keywords**: zakat distribution, Geographic Information System, K-means clustering, social welfare, Deli Serdang.

## 1. INTRODUCTION

Technology and science are developing rapidly, significantly changing people's lifestyles [1]. Current developing technology has been utilized for various purposes, such as online transactions, communication, reading access, audio, data storage, financial management, and other activities [2]. One of the technologies currently developing is the utilization of Geographic Information Systems (GIS) [3] to present information in the form of geographic data or digital mapping [4][5]. GIS can be used to analyze geographic data and combined with data mining to identify patterns more effectively and efficiently [6]. This allows the disclosure of hidden patterns, relationships, and trends in geographic data, which are useful in city planning, environmental monitoring, disaster management, and market analysis [7]. So the combination of GIS with data mining is very suitable for use as modeling in the distribution of zakat in Deli Serdang Regency to achieve a higher level of accuracy and more accurate predictions [8].

BAZNAS (National Zakat Agency) is an official institution established by the government based on Presidential Decree No. 8/2001, collecting and distributing zakat, infaq, and alms at the national level [9][10]. BAZNAS is widely spread throughout Indonesia, one of which is located in Deli Serdang Regency [11]. BAZNAS Deli Serdang Regency has several programs, one of which is the zakat empowerment program in community empowerment. Community empowerment aims to improve the quality of life of residents, especially the poor, with a focus on poverty alleviation and empowerment in various fields such as economics, education, health, and humanity [12]. This program includes assistance for working capital, capital or business equipment, capital for agricultural seeds, capital for animal husbandry, and others, as well as assistance in the fields of health, education, and humanity.

Ensuring the equitable distribution of zakat across regions is crucial for supporting the economic sustainability of zakat recipients (mustahik). In BAZNAS Deli Serdang Regency, the process for identifying zakat recipients currently lacks digitalization. This deficiency can lead to issues such as data accumulation and suboptimal grouping, which in turn may exacerbate economic disparities among recipients, cause dissatisfaction, and diminish trust in zakat management institutions.

To address these challenges, the application of the K-Means Clustering method offers a promising solution. This method enables the effective segmentation of zakat recipient data into three distinct clusters—high, medium, and low—based on their proximity to the calculated average [14], [15]. Such segmentation allows for a more targeted and efficient zakat distribution, potentially reducing the gaps in allocation and enhancing the overall management by BAZNAS Deli Serdang Regency.

This approach builds on the foundations laid by previous research. For instance, in 2021, Muhariya A's study on "Monitoring of the Family Hope Program Based on Mobile GIS Using K-Means Clustering" demonstrated that poor families could be successfully grouped into seven clusters with an accuracy level of 90.4%, indicating the high efficacy of K-Means Clustering for such applications [16]. Following this, in 2022, Solihin & Rudiman's research on "Mapping and Clustering of Muhammadiyah Schools in PPU Regency Based on Facilities, Educators and Teaching Staff" used the same method to effectively distribute resources among schools, categorizing them into clusters that clearly defined their varying needs [17].

The uniqueness of the current study lies in its focus on utilizing GIS and data mining to map and optimize zakat distribution for community empowerment in Deli Serdang Regency. This distinct application of GIS and data mining serves to

highlight the versatility and potential of these technologies in addressing specific regional challenges in different sectors. This research not only contributes to the field of zakat management but also extends the application of geospatial and data mining techniques to enhance public administration and service delivery.

The use of GIS and data mining is very suitable to overcome the problem of finding zakat distribution patterns in Deli Serdang Regency and monitoring its distribution more effectively. This study uses GIS and data mining such as K-Means Clustering [18]. Technically, the K-Means Clustering method aims to classify zakat recipient data managed by BAZNAS Deli Serdang Regency into three classes, namely low, medium, and high. This study aims to help BAZNAS Deli Serdang Regency manage zakat more efficiently and reduce the number of gaps that occur in its distribution. Based on the background above, the researcher raised the title "Identification of Territorial Distribution of Zakat Using GIS in Community Empowerment at BAZNAS Deli Serdang Regency with a Data Mining Approach.

## 2. METHODS

This study uses a quantitative method by relying on the analysis of numerical data obtained through interviews with representatives of BAZNAS Deli Serdang [19]. The data obtained is then processed to evaluate the hypothesis or find answers to research questions [20]. To collect data that supports the research study, several stages are carried out according to the research objectives [21]. There are three main methods in data collection [22]: observation, interviews, and literature reviews [23]. The process begins with an initial step that determines the objectives and development steps. The first stage is data collection, which involves observing the ongoing process or system to understand the workflow and identify problems. In addition, a literature study is conducted by reviewing references in the form of books, journals, or other relevant documents to obtain additional information as a basis for development.

After the data is collected, a needs planning is carried out which includes an analysis of the running system, identification of problems faced, calculations using the K-Means clustering algorithm to process data and determine relevant patterns, and an analysis of the proposed system as a solution. This stage ensures that system requirements can be formulated clearly. Next, a system design process is carried out which includes two main steps. First, demonstrating the system design to related parties, in this case the Deli Serdang Regency BAZNAS Office, to obtain input and ensure that the design is in accordance with user needs. Second, designing and creating a Unified Modeling Language (UML) model that represents the system workflow and designing an intuitive and easy-to-use user interface.

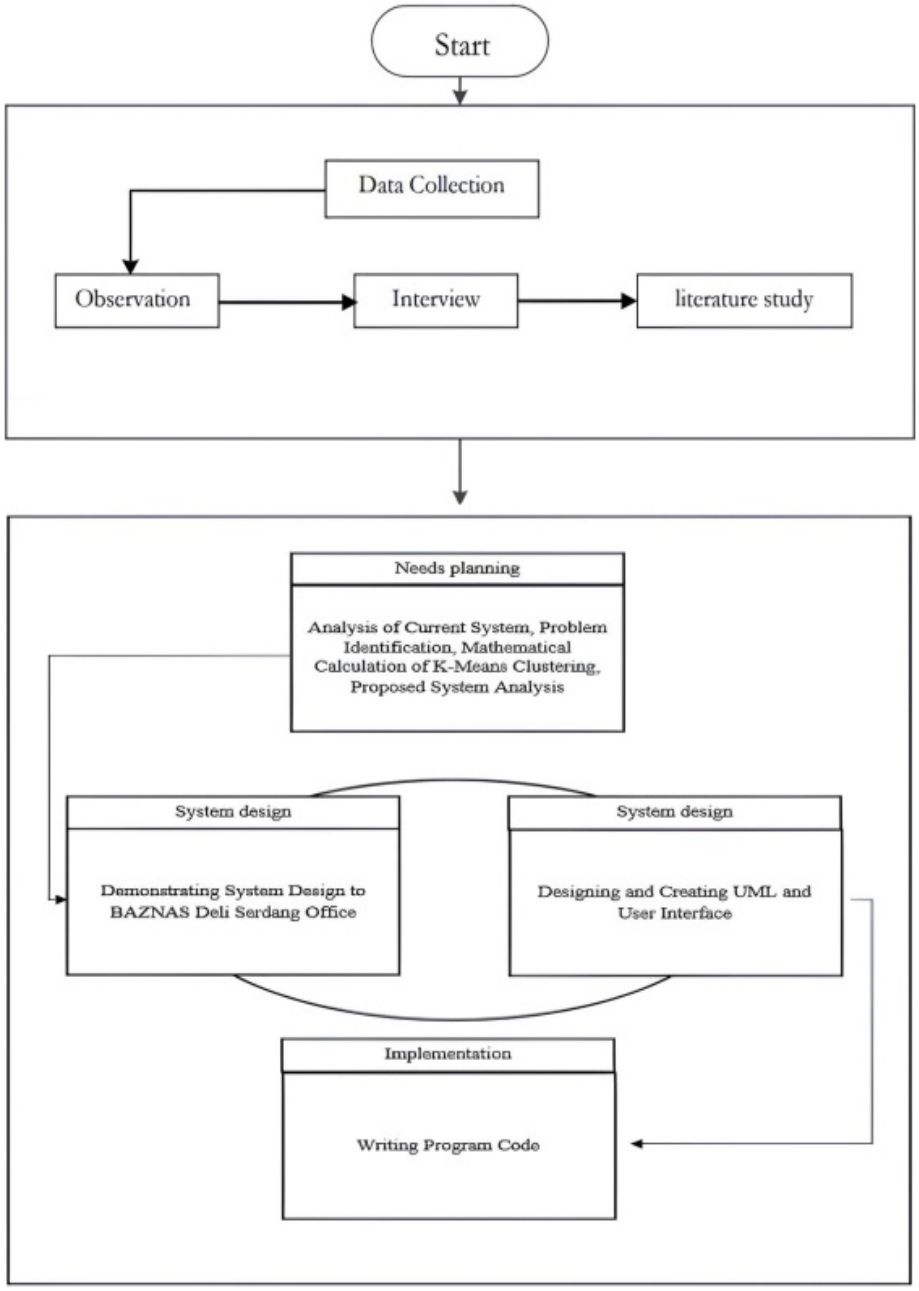


**Figure 1.** K-means Algorithm Flowchart

The next stage is implementation, where the system design that has been designed is converted into program code. Program code writing is done to technically realize the system according to the specified specifications. Finally, the entire process ends with testing and finalizing the system to ensure that the system runs well and is ready to use. This process shows an iterative approach that is carried out in stages to produce an optimal system that meets needs. This study uses the Rapid Application Development (RAD) method to develop an information system. RAD is a design methodology that accelerates development and improves quality compared to traditional methodologies [24]. Through an iterative and collaborative approach, RAD enables application development to be faster and more adaptive to changing needs, in contrast to more linear traditional methods [25]. The development process begins with rapid identification of needs and analysis, where the main requirements for the application are determined [26].

### 2.1. Klasifikasi Data dengan K-Means

At this stage, data processing uses the K-Means Clustering algorithm. The K-means clustering algorithm is an iterative clustering analysis method [27]. It starts with the random selection of K objects as the initial cluster center to calculate the distance of the object to the cluster center, assign the object to the nearest center, and periodically update the cluster center based on the objects that have been assigned [28]. The basic algorithm for Clustering with K-means in general is as shown in Figure 2.

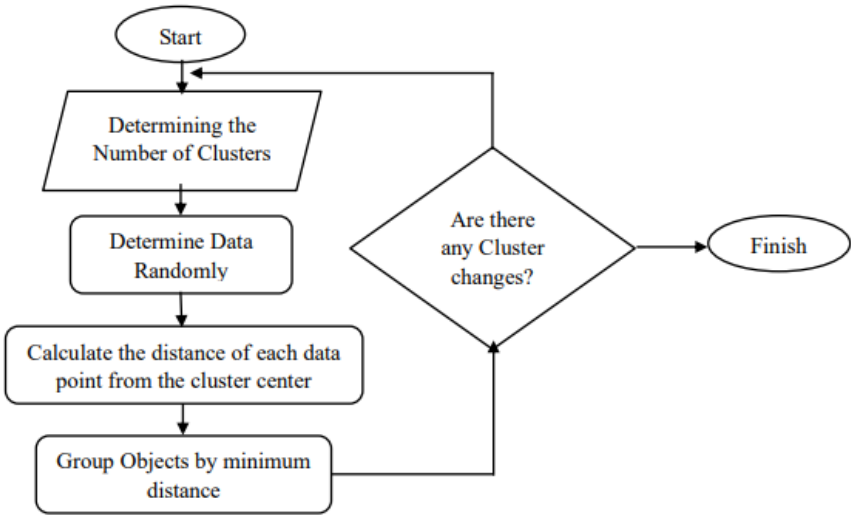


**Figure 2.** K-Means Algorithm

1) Determine the Number of Clusters: Determine the number of clusters (K) to be used in the analysis;
2) Allocate Data Randomly: Initially allocate data points into clusters randomly;
3) Calculate Distance: Calculate the distance of each data point from each cluster center using the formula as shown in Equation 1;

$$d(x_i\text{-}x_j) = \sqrt{(x_i\text{-}x_j)^2} \quad (1)$$

4) Assign Data Points: Allocate each data point to the nearest centroid (mean) based on the calculated distance;
5) Reassign and Repeat: Recalculate the cluster centers based on the assigned data points and repeat the steps of distance calculation and reassignment until no data points change clusters.

This iterative process continues until the assignment of data points to clusters is stable, resulting in a final clustering solution.

## 3. RESULTS AND DISCUSSION

### 3.1 Requirements Planning

The first stage in system development is the analysis of system requirements which is the foundation for the success of the final information system [29]. System requirements analysis, or problem-solving approach, breaks down the system into basic components to determine the interactions and work of the components in achieving the system's goals. This stage is carried out before system design and includes analysis of problems, needs, and processes. Mapping and clustering of zakat distribution results are used to make it easier for the community and BAZNAS Deli Serdang Regency to obtain information on the distribution of zakat, as well as to analyze the pattern of zakat distribution results in each sub-district. This system uses the K-means clustering method and geographic information systems, with 1765 zakat distribution data in Deli Serdang Regency in 2024 as research material.

**Table 1.** Zakat Recipients

| No | Name | Zakat | Kind of Zakat | Type | Category | Sub-district |
|---|---|---|---|---|---|---|
| 1 | Supardi | Economy | Work tool assistance | Steling Grilled Meatballs | Poor and needy | Pancur Batu |
| 2 | Nurlela | Economy | Work tool assistance | Juice Blender | Poor and needy | Pancur Batu |
| 3 | Andre Arita T | Humanity | Zakat for Converts | Rp. 300.000; | convert to Islam | Pancur Batu |

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| No | Name | Zakat | Kind of Zakat | Type | Category | Sub-district |
|---|---|---|---|---|---|---|
| 4 | Hamdani SK | Humanity | Zakat for Converts | Rp. 300.000; | convert to Islam | Pancur Batu |
| .. | .. | .. | .. | .. | .. | .. |
| 1764 | Silvia Ayu Dea | Education | Scholarship Sd | School uniforms | Less fortunate | Hamparan Perak |
| 1765 | Mira Nirmala | Education | Scholarship Sd | School uniforms | Less fortunate | Hamparan Perak |

In the clustering process that will be carried out, the cluster members are in the form of values 0 - 11. Where the value 0-11 is the code for the type of zakat. The following is the code for each type of zakat.

**Table 2.** Code of zakat

| No | Types of Zakat | Code |
|---|---|---|
| 1 | Capital Loans | 0 |
| 2 | Money Loans | 1 |
| 3 | Work Tools | 2 |
| 4 | Convert to Islam | 3 |
| 5 | Poor and needy | 4 |
| 6 | Orphans | 5 |
| 7 | Medical Equipment | 6 |
| 8 | Treatment | 7 |
| 9 | Scholarship Elementary | 8 |
| 10 | Junior High School Scholarship | 9 |
| 11 | High School Scholarship | 10 |
| 12 | S1 Scholarship | 11 |

Data on zakat recipients per sub-district is summarized in a table that shows the amount and type of zakat received. This data helps analyze the effectiveness of distribution, identify gaps, and determine the priority of zakat allocation. Before grouping using the K-means method, the data was cleaned of irrelevant or duplicate information. Cross-validation is carried out with real-world data or surveys to ensure the accuracy of the analysis results and the effectiveness of the zakat distribution strategy.

**Table 3.** Zakat distribution data based on sub-district

| No | Subdistrict | Zakat Type Code | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **0** | **1** | **2** | **3** | **..** | **8** | **9** | **10** | **11** |
| 1 | Pancur Batu | 0 | 0 | 2 | 0 | .. | 0 | 0 | 2 | 0 |

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| No | Subdistrict | Zakat Type Code | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **0** | **1** | **2** | **3** | **..** | **8** | **9** | **10** | **11** |
| 2 | Bangun Purba | 1 | 0 | 0 | 0 | .. | 2 | 0 | 0 | 0 |
| 3 | Stm Hilir | 0 | 1 | 0 | 0 | .. | 0 | 0 | 2 | 0 |
| 4 | Gunung Meriah | 1 | 0 | 0 | 0 | .. | 0 | 4 | 0 | 0 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| 7 | Tanjung Morawa | 0 | 0 | 0 | 9 | | 0 | 0 | 0 | 0 |
| .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| 21 | Deli Tua | 0 | 0 | 0 | 0 | .. | 0 | 2 | 0 | 0 |
| 22 | Hamparan Perak | 0 | 0 | 0 | 0 | .. | 2 | 0 | 0 | 0 |

### 3.2 Kmeans Clustering Process

In this study, the selected grouping parameters include the selection of the initial centroid and the number of clusters used. The initial centroid is randomly selected from the existing data range, which is between 0 and 200, to provide a diverse starting point for the K-means algorithm, thus allowing for a more effective exploration of various clustering possibilities. The selection of three clusters was based on the need to group zakat recipients into clear categories: high, medium, and low recipient clusters, which made it easier for BAZNAS Deli Serdang Regency to identify areas with different zakat needs and plan a more targeted distribution. To ensure the validity of the grouping results, the cross-validation method is applied by comparing the cluster results obtained with the existing zakat management system. Suppose the author chooses the following centroid value.

Centroid 0 : 0
Centroid 1 : 7
Centroid 2 : 100

By using the centroid value, the data for Tanjung Morawa District will be calculated, which has the following details with the order of zakat names according to Table 3. Tanjung Morawa: [0,0,0,9,200,10,10,10,0,0,0,0]

Calculate the distance of data to each centroid using the Euclidean formula. Here is the data calculation for centroid 0:

$$ED_{1} = \sqrt{\frac{(0-0)(0-0)(0-0)(9-0)(200-0)(10-10)}{(10-0)(10-0)(0-0)(0-0)(0-0)(0-0)^2}} \quad (2)$$

$$= (0)(0)(0)(9)(200)(10)(10)(10)(0)(0)(0)(0)$$

Then continue with data calculation against centroid 1 :

$$ED_{2} = \sqrt{\begin{matrix}(0-7)(0-7)(0-7)(9-7)(200-7)(10-7)\\(10-7)(10-7)(0-7)(0-7)(0-7)(0-7)^2\end{matrix}} \quad (3)$$

$$=(7)(7)(7)(2)(193)(3)(3)(3)(7)(7)(7)(7)$$

And the last is the calculation of data against centroid 2 :

$$ED_{3} = \sqrt{\begin{matrix}(0-90)(0-90)(0-90)(9-90)(200-90)(10-90)\\(10-90)(10-90)(0-90)(0-90)(0-90)(0-90)^2\end{matrix}} \quad (4)$$

$$=(90)(90)(90)(81)(110)(80)(80)(80)(90)(90)(90)(90)$$

After the distance of all data is calculated against each cluster, the cluster of the data is determined by considering the lowest value of the data in the distance calculation. Therefore, the results of the cluster members in the first iteration are as follows.

**Table 4.** Cluster members in the first iteration

| No | Types of Zakat | Code | C0 | C1 | C2 | Distance | Cluster |
|---|---|---|---|---|---|---|---|
| 1 | Capital Loans | 0 | 0 | 7 | 90 | 0 | C0 |
| 2 | Money Loans | 1 | 0 | 7 | 90 | 0 | C0 |
| 3 | Work Tools | 2 | 0 | 7 | 90 | 0 | C0 |
| 4 | Convert to Islam | 3 | 9 | 2 | 81 | 2 | C1 |
| 5 | Poor and needy | 4 | 200 | 193 | 110 | 110 | C2 |
| 6 | Orphans | 5 | 10 | 3 | 80 | 10 | C1 |
| 7 | Medical Equipment | 6 | 10 | 3 | 80 | 10 | C1 |
| 8 | Treatment | 7 | 10 | 3 | 80 | 10 | C1 |
| 9 | Scholarship Elementary | 8 | 0 | 7 | 90 | 20 | C0 |
| 10 | Junior High School Scholarship | 9 | 0 | 7 | 90 | 20 | C0 |
| 11 | High School Scholarship | 10 | 0 | 7 | 90 | 20 | C0 |
| 12 | S1 Scholarship | 11 | 0 | 7 | 90 | 20 | C0 |

The results of the zakat distribution cluster analysis group the data into three categories: C0, C1, and C2. The C0 cluster includes Capital Loans, Money Loans, Work Tools, and scholarships (elementary to S1), with low priority and a small number of recipients. Cluster C1 includes Convert to Islam, Orphans, Medical Equipment, and Treatment, with an intermediate distribution level. Cluster C2, which includes only Poor and Needy, shows the highest need with the largest distribution. The distribution focus needs to be directed to the C2 cluster, while C0 and C1 can be optimized according to priority.

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### 3.3 Update Centroid

After determining the cluster for each data point in the first iteration, the centroid value is updated in each iteration. Then a new centroid is obtained based on the centroid value being the average of all member values in the cluster.

Centeroid 0 : 0
Centeroid 1 : 9,75
Centeroid 2 : 200

**Table 5.** Cluster members on the second iteration results

| No | Types of Zakat | Code | C0 | C1 | C2 | Distance | Cluster |
|---|---|---|---|---|---|---|---|
| 1 | Capital Loans | 0 | 0 | 9,75 | 200 | 0 | C0 |
| 2 | Money Loans | 1 | 0 | 9,75 | 200 | 0 | C0 |
| 3 | Work Tools | 2 | 0 | 9,75 | 200 | 0 | C0 |
| 4 | Convert to Islam | 3 | 9 | 0,75 | 191 | 0,75 | C1 |
| 5 | Poor and needy | 4 | 200 | 190,25 | 0 | 0 | C2 |
| 6 | Orphans | 5 | 10 | 0,25 | 190 | 0,25 | C1 |
| 7 | Medical Equipment | 6 | 10 | 0,25 | 190 | 0,25 | C1 |
| 8 | Treatment | 7 | 10 | 0,25 | 190 | 0,25 | C1 |
| 9 | Scholarship Elementary | 8 | 0 | 9,75 | 200 | 0 | C0 |
| 10 | Junior High School Scholarship | 9 | 0 | 9,75 | 200 | 0 | C0 |
| 11 | High School Scholarship | 10 | 0 | 9,75 | 200 | 0 | C0 |
| 12 | S1 Scholarship | 11 | 0 | 9,75 | 200 | 0 | C0 |

The results of the second iteration analysis show three groups: Cluster C0 (Capital Loans, Money Loans, Work Tools, and Elementary, Junior High, High School, S1 scholarships) with a distance of 0, reflecting low needs; Cluster C1 (Convert to Islam, Orphans, Medical Equipment, Treatment) with a distance of 0.25-0.75, shows a moderate distribution; and Cluster C2 (Poor and Needy) with a distance of 0, reflecting very high needs. The top priority needs to be given to Cluster C2, while the distribution on C0 and C1 can be optimized.

The next step is to cluster the data to the nearest centroid and recalculate the centroid. The next result will produce the same result as the second iteration. Therefore, the clustering process has converged. Below is the result of the clustering process after reaching the converged centroid value. The following shows the final cluster assignment for each district after several iterations leading to convergence.

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**Table 6.** Clustering results

| No | Subdistrict | C0 | C1 | C2 |
|---|---|---|---|---|
| 1 | Pancur Batu | 0,1,2 | 3,5,6,7,8,9,10,11 | 4 |
| 2 | Bangun Purba | 0,1,2,3 | 5,6,7,8,9,10,11 | 4 |
| 3 | STM Hilir | 0,1,2,3 | 5,6,7,8,9,10,11 | 4 |
| .. | .. | .. | .. | .. |
| 7 | Tanjung Morawa | 0,1,2,8,9,10,11 | 3,5,6,7 | 4 |
| .. | .. | .. | .. | .. |
| 20 | Sunggal | 0,1,2,3 | 5,6,7,8,9,10,11 | 4 |
| 21 | Deli Tua | 0,1,2,3,5 | 6,7,8,9,10,11 | 4 |
| 22 | Hamparan Perak | 0,1,2,3 | 5,6,7,8,9,10,11 | 4 |

In Table 5, there are 3 categories of cluster distribution for each district. Based on the adjustments made to the available data, it can be concluded that members of cluster C0 represent LOW quantity zakat, members in cluster C1 represent MEDIUM quantity zakat, and members in cluster C2 represent HIGH quantity zakat.

### 3.4 Current System Analysis

In the current system, the zakat distribution procedure is not fully managed by BAZNAS. As an institution that acts as the main facilitator, BAZNAS has the responsibility to distribute zakat after receiving a list of recipients from each region. This process begins with the collection and verification of zakat recipient data carried out by regional zakat institutions, which are then submitted to BAZNAS.

### 3.5 Proposed System Analysis

In the proposed system design for this study, there will be a System Admin who will have full control over all system functions and operations. This Admin will be the main actor in the system who can manage various aspects of zakat data, starting from entering zakat recipient data, updating data, to deleting irrelevant data from the database.

The proposed system is designed to make it easier for BAZNAS Deli Serdang Regency to manage and analyze zakat data efficiently and effectively. By utilizing Geographic Information System (GIS) technology and a data mining approach, this system will allow BAZNAS to perform spatial mapping of zakat distribution and analyze distribution patterns based on various demographic and geographic factors.

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Use Case Diagram is a visual model that describes the behavior of the system to be created [30]. Use Case Diagram shows the interaction between actors and systems, helping to understand the functions in the system and who can use it [31]. Use Case Diagram does not provide a detailed explanation of the use of each use case, but only provides a brief overview of the relationship between use cases, actors, and systems. With this diagram, we can find out the functions in the system [32]. In this study, the actors or users who will use this system are the Branch Manager of BAZNAS Deli Serdang Regency and the Community. The functions in the system and the interaction of actors with these functions can be seen in Figure 3.

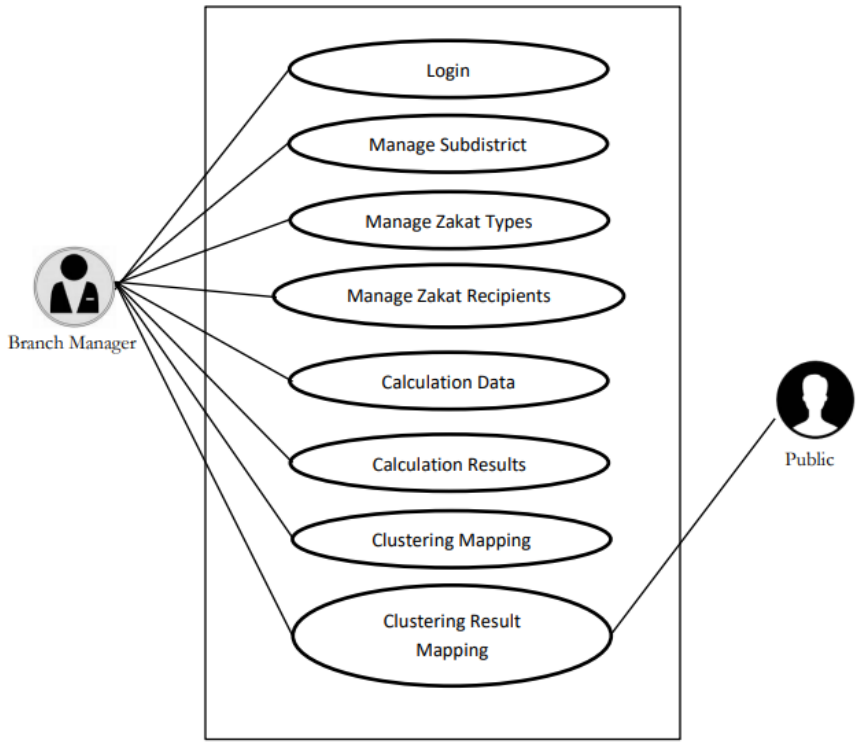


**Figure 3.** Usecase diagram of proposed system

### 3.6 Integrating Maps and K-Means on a Website

To connect K-Means with maps on a website, first collect geospatial data that includes latitude and longitude coordinates for various locations. Next, apply the K-Means algorithm to cluster the data into groups based on the desired number of clusters. The clustering results should then be stored in JSON format along

with the coordinates for each district. Here are the coordinates of some of the districts analyzed:

**Table 7.** District Coordinates

| No | Subdistrict | Lattitude | Longitude |
|---|---|---|---|
| 1 | Labuhan Deli | 3.6675 | 98.7200 |
| 2 | Hamparan Perak | 3.7769 | 98.5228 |
| 3 | Lubuk Pakam | 3.5681 | 98.8439 |
| .. | .. | | |
| 20 | Sibolangit | 3.3093 | 98.4689 |
| 21 | STM Hulu | 3.2520 | 98.6146 |
| 22 | Gunung Meriah | 3.1261 | 98.5834 |

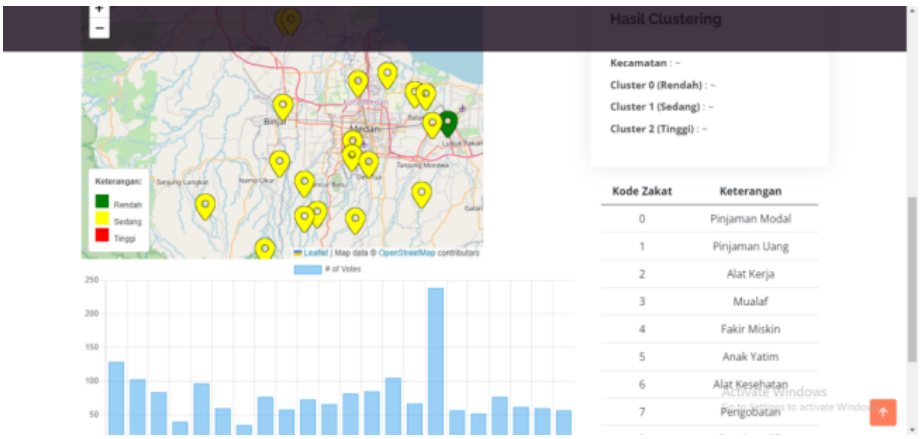


**Figure 4.** Dashboard User

Next, integrate the clustering results with an interactive map on the website using the Google Maps service. By combining the Google Maps API, add markers to the map to indicate the location within each cluster. This approach provides a clear and interactive visualization of geospatial data for website visitors, allowing them to better understand data patterns and distributions. The system built to perform the grouping process using K-Means is a website. The website is built using the PHP and JavaScript programming languages using MySQL. On the user page, the website displays a map showing points from each sub-district. Red dots indicate sub-districts with the largest number of zakat recipients, yellow dots indicate sub-districts with medium numbers of zakat recipients, while green dots represent sub-districts with fewer zakat recipients, as shown in Figure 4. When one of the points on the map is selected, a description of the clustering results of that sub-district will appear, providing complete details regarding the distribution of zakat in that area. The cluster as shown in Figure 5.

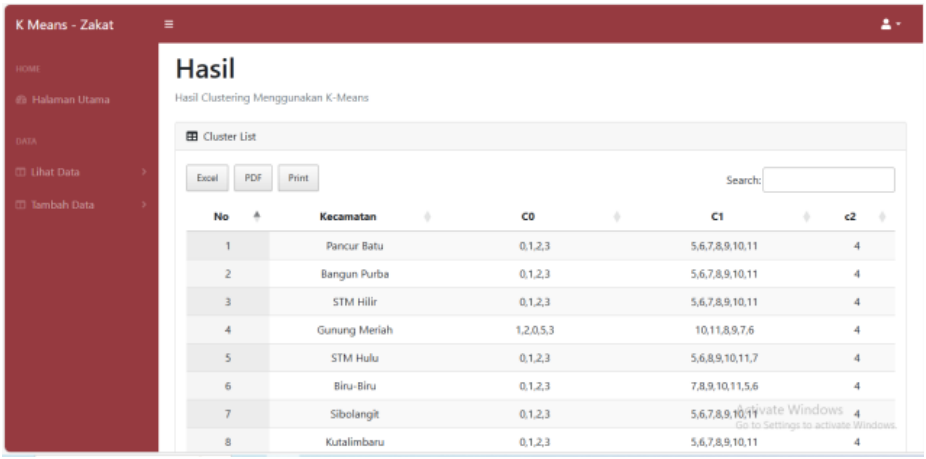


**Figure 5.** Admin Cluster Page

## 4. CONCLUSION

The results of this study indicate that the application of Geographic Information Systems (GIS) and the K-means clustering method is effective in analyzing and mapping the distribution of zakat in Deli Serdang Regency. This algorithm successfully grouped zakat data from 22 regencies in Deli Serdang into 3 clusters, namely High Recipients, Medium Recipients, and Low Recipients. The analysis identified Tanjungmorawa District as the area with the highest zakat distribution, with 239 recipients. This indicates that the need for zakat in the district is greater than other areas. This study can help BAZNAS Deli Serdang Regency in optimizing the management and distribution of zakat, ensuring that assistance is more targeted, and reducing social reach. The use of GIS and data mining technology not only increases distribution efficiency, but also provides a deeper understanding of zakat distribution patterns, enabling strategic steps to improve community empowerment in a sustainable manner. For the next step, it is hoped that BAZNAS will integrate the GIS system into daily operations to increase efficiency and accuracy in planning and distributing zakat. In addition, future research may extend this model to other regions to test its effectiveness in different contexts, as well as combine real-time data, such as demographic and economic data, to generate more responsive insights.

## REFERENCES

[1] M. Imbalo Zaki Hasibuan and T. Triase, "Implementasi Sistem Database NoSQL Secara Real Time Menggunakan Firebase Realtime Database pada Aplikasi Ourticle," SIBATIK J. J. Ilm. Bid. Sos. Ekon. Budaya, Teknol. dan Pendidik., vol. 2, no. 1, pp. 1–24, 2022, doi: 10.54443/sibatik.v2i1.489.

[2] R. B. Nuerita Maharani, M. I. P. Nasution, and T. Triase, "Sistem Informasi Payroll Pegawai dengan Absensi QR Code," J. Inform. dan Teknol. Pendidik., vol. 1, no. 1, pp. 23–35, 2021, doi: 10.25008/jitp.v1i1.9.
[3] O. A. Mohammed, S. Vafaei, M. M. Kurdalivand, S. Rasooli, C. Yao, and T. Hu, "A Comparative Study of Forest Fire Mapping Using GIS-Based Data Mining Approaches in Western Iran," 2022.
[4] N. R. F. Ramadhani, E. Prasetyaningrum, and L. Bachtiar, "Sistem Informasi Geografis Apotek di Kotawaringin Timur Berbasis Web," Build. Informatics, Technol. Sci., vol. 2, no. 2, pp. 141–150, 2020, doi: 10.47065/bits.v2i2.549.
[5] Y. Rahmanto, S. Hotijah, and . Damayanti, "Perancangan Sistem Informasi Geografis Kebudayaan Lampung Berbasis Mobile," J. Data Min. dan Sist. Inf., vol. 1, no. 1, p. 19, 2020, doi: 10.33365/jdmsi.v1i1.805.
[6] Basri, A. Achamad, Hazriani, and C. S. Munthakhabah R, "Sistem Informasi Geografis Pemetaan dan Prediksi Pertumbuhan Penduduk Menggunakan Regresi Linear," Bull. Inf. Technol., vol. 4, no. 2, pp. 171–177, 2023, doi: 10.47065/bit.v4i2.633.
[7] Kusmanto, S. Samsir, R. Watrianthos, and S. Suryadi, "Distribusi Spasial Unmet Need Pelayanan Kesehatan dengan Algoritma K-Means untuk Pemetaan Provinsi di Indonesia," Bull. Inf. Technol., vol. 4, no. 3, pp. 362–368, 2023, doi: 10.47065/bit.v4i3.862.
[8] M. Gulyaeva et al., "Data mining and model - predicting a global disease reservoir for low - pathogenic Avian Influenza ( AI ) in the wider pacific rim using big data sets," Sci. Rep., pp. 1–11, 2020, doi: 10.1038/s41598-020-73664-2.
[9] M. Mustikasari et al., "Analisis Kepuasan Mustahik Terhadap Pelayanan Badan Zakat Nasional (BAZNAS) Kota Bandung," J. Ilmu Multidisiplin, vol. 2, no. 2, pp. 179–192, 2023.
[10] Nur Aini and A. Mundir, "Pengelolaan Zakat, Infaq dan Sedekah dalam Upaya Meningkatkan Pendapatan Ekonomi Pelaku UMKM di BAZNAS Kota Pasuruan," Malia (Terakreditasi), vol. 12, no. 1, pp. 95–108, 2020, doi: 10.35891/ml.v12i1.2367.
[11] M. Ilzam Harahap, "Analisis Efektivitas Penyaluran Zakat Menggunakan Metode Zakat Core Principles Oleh BAZNAS Deli Serdang," vol. 419, no. 2, pp. 419–427, 2023.
[12] N. Nurhayati, A. Afifudin, and S. A. Anwar, "Efektivitas pendistribusian zakat dalam pemberdayaan ekonomi masyarakat," El-Aswaq Islam. Econ. Financ. J., vol. 3, no. 1, pp. 1–9, 2022.
[13] Z. H. Utomo and A. S. Qulub, "Baznas Jawa Timur Dan Pemberdayaan Masyarakat Disabilitas Ponorogo," J. Ekon. Syariah Teor. dan Terap., vol. 7, no. 3, p. 544, 2020, doi: 10.20473/vol7iss20203pp544-562.

[14] K. Kandali, L. Bennis, and H. Bennis, "A New Hybrid Routing Protocol Using a Modified K-Means Clustering Algorithm and Continuous Hopfield Network for VANET," IEEE Access, vol. 9, pp. 47169–47183, 2021, doi: 10.1109/ACCESS.2021.3068074.
[15] X. Ran, X. Zhou, M. Lei, W. Tepsan, and W. Deng, "A novel K-means clustering algorithm with a noise algorithm for capturing urban hotspots," Appl. Sci., vol. 11, no. 23, 2021, doi: 10.3390/app112311202.
[16] A. Muhariya, B. Widada, and S. Siswanti, "Monitoring Program Keluarga Harapan Berbasis Mobile GIS Menggunakan K-Means Clustering," Techno.Com, vol. 20, no. 4, pp. 468–477, 2021, doi: 10.33633/tc.v20i4.4463.
[17] M. R. Sholihin and Rudiman, "Pemetaan Sekolah Muhammadiyah di Kabupaten PPU Berdasarkan Fasilitas , Pendidik dan Tenaga Pendidik Menggunakan Metode K-Means Clustering," J. Keilmuan dan Apl. Tek. Inform., vol. 5, no. 36, pp. 45–51, 2022.
[18] Y. Filki, "Algoritma K-Means Clustering dalam Memprediksi Penerima Bantuan Langsung Tunai (BLT) Dana Desa," J. Inform. Ekon. Bisnis, vol. 4, pp. 166–171, 2022, doi: 10.37034/infeb.v4i4.166.
[19] Eniyati, Z. KP, L. Yulaikhah, and R. Prahesti, "Analisis Kuantitatif dan Kualitatif Dokumen Rekam Medis Pasien Bersalin di Klinik Pratama Aisyiyah Siti Khotijah Salam Magelang," Heal. Indones. J., vol. 2, no. 1, pp. 14–21, 2023.
[20] A. Rakhmaniar, "Analisis Kuantitatif Tentang Pengaruh Komunikasi Verbal Dan Nonverbal Dalam Proses Negosiasi Bisnis," no. 1, 2024.
[21] B. M. Kareli, E. T. Maziriri, and T. Chuchu, "Modelling Key Obstacles Hindering The Business Performance of Small and Medium Enterprises Within The Mangaung Metropolitan Area in South Africa," Indones. J. Bus. Entrep., vol. 9, no. 3, pp. 347–358, 2023, doi: 10.17358/ijbe.9.3.347.
[22] A. Z. Syahputri, F. Della Fallenia, and R. Syafitri, "Kerangka berfikir penelitian kuantitatif," Tarb. J. Ilmu Pendidik. dan Pengajaran, vol. 2, no. 1, pp. 160–166, 2023.
[23] A. Khaeru, R. Astuti, and N. Suarna, "Sistem Informasi Ekstrakurikuler Untuk Meningkatkan Pelayanan Kegiatan Di Sman 1 Sumberjaya," JATI (Jurnal Mhs. Tek. Inform., vol. 6, no. 2, pp. 856–860, 2022, doi: 10.36040/jati.v6i2.5759.
[24] A. R. A. P. Ahmad, T. Triase, and M. Alda, "Aplikasi Pemesanan Layanan Laundry Pada Noda Laundry Dengan Integrasi Midtrans Payment Gateway, Dikembangkan Untuk Platform Android," JTIK (Jurnal Tek. Inform. Kaputama), vol. 8, no. 1, pp. 8–14, 2024, doi: 10.59697/jtik.v8i1.488.
[25] F. A. Ulwanda and M. Alda, "Cap Rajawali Tebing Tinggi Menggunakan Metode Distribution Requirement Planning ( DRP )," vol. 4307, no. August, pp. 1053–1059, 2024.

[26] W. D. Prastowo, D. Danianti, and A. Pramuntadi, "Analisis Risiko Pada Pengembangan Perangkat Lunak Menggunakan Metode Agile Dan Rad (Rapid Application Development)," Citiz. J. Ilm. Multidisiplin Indones., vol. 3, no. 3, pp. 169–174, 2023, doi: 10.53866/jimi.v3i3.388.

[27] F. Andini, D. Zilfitri, Y. Filki, and M. Ridho, "Algoritma K-Means Clustering dalam Optimalisasi Komposisi Pakan Ternak Ayam Petelur," J. Sistim Inf. dan Teknol., vol. 5, pp. 44–48, 2022, doi: 10.37034/jsisfotek.v5i2.168.

[28] Z. Huang, H. Zheng, C. Li, and C. Che, "Application of Machine Learning-Based K-means Clustering for Financial Fraud Detection," Acad. J. Sci. Technol., vol. 10, no. 1, pp. 33–39, 2024, doi: 10.54097/74414c90.

[29] 2021 Rufaidah, Lestari and Wahyudin, "Metode Material Requirement Planning (MRP) untuk Perencanaan Kebutuhan Bahan Baku pada Produksi," Optimalisasi, vol. 7, no. April, pp. 16–24, 2021.

[30] F. Marwan, A. Zakir, and E. Rahayu, "Sistem Informasi Geografis Capaian Vaksinasi Covid-19 Kabupaten Labuhanbatu Utara Berbasis Webgis Menggunakan Algoritma K-Means," Snastikom, 2022.

[31] M. Rakha, M. Hermawati, and N. Dwitiyanti, "Sistem Absensi Menggunakan Qr Code Scanner Berbasis Android Pada Pt. Indobara Bahana," Semnas Ristek (Seminar Nas. Ris. dan Inov. Teknol., vol. 6, no. 1, pp. 1074–1081, 2022, doi: 10.30998/semnasristek.v6i1.5855.

[32] M. Alda, O. Ariansah Pane, M. R. Syuhada, and S. Dara Efita, "Aplikasi Absensi Karyawan Gapyeong Korean BBQ Lubuk Pakam Menggunakan QR Code Berbasis Android," vol. 8, pp. 2948–2957, 2024.