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Application of Data Mining to Determine the Spread of Tuberculosis Disease in Bogor District

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Abstract

Tuberculosis (TB) is a disease caused by Mycobacterium tuberculosis and transmission of tuberculosis easily occurs through the air. The prevalence rate of TB patients in Indonesia is estimated at 289 per 100 thousand population and the incidence is 189 per 100 thousand population. 27 out of 1,000 people are threatened with death and need an effective handling effort. The need for an effective handling effort to overcome the spread of TB, one of these efforts is by grouping the areas of TB disease spread in Bogor Regency. This grouping aims to find out which areas have high, medium, and low levels of tuberculosis cases. The results of this study are expected to be a recommendation for the Bogor Regency Government in handling TB more effectively.

Keywords: *Tuberculosis, Application, Data Mining*

1. INTRODUCTION

Tuberculosis (TB) is a disease caused by Mycobacterium tuberculosis and the transmission of tuberculosis easily occurs through the air, especially if the infection has attacked people with positive BTA test results, when the patient coughs or sneezes, germs are airborne and can be found in droplets. Coughing can cause about 3,000 droplets to be released. (Aini dkk., 2017).

Tuberculosis (TB) is an infectious disease that is still a global concern. When someone has TB disease, symptoms may include coughing, fever, night sweats, or weight loss. This can cause delays in seeking help and lead to the spread of the bacteria to others. In one year, a person with active TB can infect 5-15 other people through close contact.

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Without appropriate treatment, on average 45% of HIV-negative people with TB and almost all HIV-positive people with TB will die (WHO, 2022).

To date, no country is TB-free. Mortality and morbidity rates due to the mycobacterium tuberculosis germ are high. The prevalence rate of TB patients in Indonesia is estimated at 289 per 100,000 population and the incidence rate is 189 per 100,000 population. 27 out of 1,000 people are at risk of dying as reported by the Directorate General of Disease Control and Environmental Health, Ministry of Health of the Republic of Indonesia, compiled in 2011 regarding tuberculosis (TB) in Indonesia.

With these problems, an effective handling effort may be needed. One of these efforts is to categorize the areas of TB disease spread in Bogor Regency. This grouping aims to determine which areas have high, medium, and low levels of tuberculosis cases.

The results of this study are expected to be a recommendation for the Bogor Regency Government in conducting a more effective handling of TB disease. Where the problem identification shows that; (1) The Bogor Regency Health Office has difficulty in the process of grouping the spread of TB disease in Bogor Regency, (2) The process of grouping the spread of TB disease in Bogor Regency is currently done manually so it is still inefficient, (3) The process of collecting data on the spread of TB disease at the village level to the district level is still slow so that data collection is delayed, (4) The number of cases that are not recorded quickly and efficiently for the spread of TB disease in Bogor Regency, (5) The mismatch between manual data and in the field so that it needs verification or accurate data using a system so that the structured data on the spread of TB, (6) Making reports on the spread of TB disease in Bogor Regency is often late given to the head of the department because the process is still done manually.

The Bogor Regency government can focus more on areas that have high levels of tuberculosis cases so that the number of tuberculosis cases in Bogor Regency can be spread using the clustering method. The way the clustering method works is by combining data objects that have similar properties or characteristics into one small group (cluster). In its implementation, the clustering method must carry out the algorithm stages so that its objectives can be achieved. The k-means algorithm can be implemented in the

clustering method. The task of k-means is to divide data into several groups based on the level of similarity.

2. LITERATURE REVIEW

The Definition of Application

According to (Dinata, 2015), An application is software that contains a code or instruction that can be altered based on the user's preferences by storing something in the form of data, problems, or work into a means or media that can be applied into a new form.

The Definition of Administration

Administration in everyday life or the world of work must be familiar with the term administration. This word is often found and used in everyday life. However, not all know what exactly is meant by the administration itself.

According to (Dewi, 2015) in the introductory administration book, the administration has an understanding in the sense that it is writing or administrative or secretarial work, which includes receiving, recording, collecting, processing, organizing, sending, and storing activities.

The Definition of Data Mining

The scientific discipline of data mining combines methods from databases, statistics, machine learning, data visualization, and pattern recognition to address the issue of information retrieval from massive databases. (Werdiningsih, 2020).

According to Larose's book Discovering Knowledge in Data: An Introduction to Data Mining, data mining is the process of utilizing pattern recognition technologies like statistics and mathematical techniques to mine vast amounts of data repositories in order to find new, useful correlations, patterns, and trends. These days, datamining is expanding quickly due to its capacity to extract valuable patterns and trends from pre-existing databases. Despite the fact that data repositories contain important information, companies have spent billions of dollars gathering megabytes or terabytes of data with little discernible advantage.

The Definition of K-Means

According to Vulandari (2017), The k-means method creates cluster values (k) at random, and the value that results becomes the centroid, or center of the cluster. Following that, use a formula to determine the distance between each centroid and each piece of existing data until the centroid value remains constant (stable).

The k-means algorithm is a data mining or data analysis technique that uses a partition system to classify data and conducts an unsupervised modeling process. The goal of the k-means approach is to divide the available data into many groups, with the data in one group sharing characteristics with each other and having distinct features from the data in other groups. To put it another way, this approach seeks to maximize variation with data in other clusters and decrease variation with data inside a cluster. One of the techniques used in clustering exercises is K-Means, which works well for locating clusters in a large amount of data.

The Definition of Clustering

According to (Fauzi & Yudi, 2017) Clustering is an activity in grouping various kinds of data records, observations, or approaching data from an object with other objects that have certain similarities. A cluster is a collection of data rows that have similarities and dissimilarities to record into other clusters. Clustering differs from classification in that there is no target variable for clustering. The task of clustering does not attempt to classify, estimate, or predict a value of the target variable. Instead, clustering algorithms attempt to segment a set of data into relatively homogeneous clusters into subsections or clusters. Where the similarity of a data record is increased while the dissimilarity of the data is decreased out of the similarity cluster.

UML (*Unified Modelling Language*)

The definition of Unified Modeling Language (UML) is software with an object-oriented paradigm. Modeling is used to simplify complex problems in such a way that it is easier to learn and understand (Maimunah et al., 2017). UML (Unified Modeling

Language) is generally grouped into structural and behavioral diagrams of the two groups that are most often used in designing a system, namely use case diagrams, activity diagrams, class diagrams, and sequence diagrams.

Java Programming Language

According to (Oftware, 2015) Java is a computer programming language developed by Sun Microsystems. Programming languages are used to give instructions to computers to perform specific tasks. Java is a new language (created in 1995) and has been very successful for many reasons. Java can be used to develop many different types of applications. There are simple text-based programs called console applications. These programs only support text input and output to your computer screen. You can also build graphical user interface (GUI, pronounced 'sticky') applications. These are applications with menus, toolbars, buttons, scroll bars, and other controls that rely on the computer mouse for input. Examples of GUI applications you may have in use are word processors, spreadsheet programs, and computer games. Java programming language is a development of the C++ programming language Java programming language is much more reliable than Java and can create all forms of programming from desktop applications to mobile applications, so Java is very suitable as a programming language for programmers who use it.

MySQL

My Structured Query Language (MySQL) is a multi-user database management system software. Because it is open source and can accommodate a very large capacity, MySQL has become a very popular database among web programmers. MySQL can be run on two of the most popular operating systems today, Windows and Linux. MySQL is free software under the GPL (General Public License) license. Everyone is free to use MySQL. MySQL is a derivative of one of the main concepts in databases for a long time, namely SQL (Structured Query Language).

3. RESEARCH METHOD

Time and Place of Research

The implementation of the research was carried out for 5 months starting in March 2024 until July 2024 in the Bogor Regency area. The application program design activities are located at Jl. Tegar Beriman Tengah, Kec, Cibinong Bogor Regency, West Java 16914.

Research Stages

The following stages of the above research stages are as follows:

1. Literature Study At this stage the author collects data and information carried out for the design of the application system for determining the spread of tuberculosis disease by studying literature books and journals on analyzing and designing a system.
2. Interview The author conducted an interview with the Head of the Bogor Regency Health Office about the spread of TB disease in Bogor Regency.
3. Document Analysis Needs analysis is useful for obtaining data that will be used as input from a system and to obtain data related to this final project. The process of the application system to determine the spread of TB disease starts from understanding the user.
4. Determining Research Methods The author determines the right method in completing the application system to determine the spread of TB disease.
5. Data Processing Then the author processes the data that has been obtained from the Bogor Regency Region in the application process to determine the spread of TB disease.
6. Method / Model Testing The author tests the research method used, namely the K-Means algorithm.
7. Designing Applications At this stage the author designs an application system to determine the spread of TB disease following the needs of the Bogor Regency Region and an application display that is easily understood by users.

8. Application Testing After the application has been designed, the next stage is the application testing process if there is still something that is not correct in the application design, it will be revised by the author.

3. RESULTS AND DISCUSSION

Algorithm Discussion

The K-Means algorithm is a clustering method that aims to divide a set of data into several groups (clusters) based on similar features. This algorithm works by minimizing the sum of the squares of the distance between the data points and the cluster center (centroid).

a. Data Normalization

Before starting clustering, we normalize the data to ensure each feature is on the same scale.

b. Cluster Center Initiation

Suppose we want to divide the data into 2 clusters (k=2). We will initialize the cluster centers randomly. For example, we choose patient 1 and patient 7 as the initial cluster centers.

- Cluster 1 Center: (25, 0, 1, 1.0, 1.0)
- Cluster 2 Center: (37, 0, 1, 4.0, 4.0)

a. Assign Cluster

Calculate the Euclidean distance from each patient to the cluster center and assign the patient to the cluster with the closest distance. With the formula:

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

Example of distance calculation:

Pasien 2 ke Cluster 1 Center :

$$d = \sqrt{\begin{matrix}(34-25)^2 + (1-0)^2 + (2-1)^2 \\ +(2.0-1.0)^2 + (1.5-1.0)^2\end{matrix}}$$

Patient 2 to Cluster 2 Center:

$$d = \sqrt{\begin{matrix}(34-37)^2 + (1-0)^2 + (2-1)^2 \\ +(2.0-4.0)^2 + (1.5-4.0)^2\end{matrix}}$$

Patient 2 is closer to Cluster 2 Center.

b. Cluster Center Update

After grouping all patients, recalculate the cluster center as the average of all data points in that cluster. For example, patients included in Cluster 1 are patients 1, 3, and 6, while patients included in Cluster 2 are patients 2, 4, 5, 7, 8, 9, 10.

New Cluster Center 1 :

$$(\mu 1, \mu 2, \mu 3, \mu 4, \mu 5) = \left(\frac{25+22+26}{3}, \frac{0+0+1}{3}, \frac{1+3+3}{3}, \frac{0+2.0+2.5}{3}, 1.\right)$$

$$= (24.33, 0.33, 2.33, 1.17, 1.83)$$

New Cluster Center 2:

$$(\mu 1, \mu 2, \mu 3, \mu 4, \mu 5) = \left(\frac{34+45+33+37+29+41+38}{7}, \frac{1+1+0+0+1+0+1}{7}, \frac{2+1+2+1+2+3+1}{7}, \frac{2.0+3.0+2.5+4.0+3.5+2.0+4.5}{7}, \frac{1.5+3.5+2.0+4.0+3.0+3.5+4.0}{7}\right)$$

$$= (36.71, 0.57, 1.71, 3.07, 3.21)$$

c. Repeat Until Convergence

Repeat the steps of assigning clusters and updating cluster centers until the cluster centers no longer change significantly or after reaching the maximum number of iterations.

d. Result

After several iterations, the clustering results might be as follows:

Cluster 1: Patients 1, 3, 6

Cluster 2: Patients 2, 4, 5, 7, 8, 9, 10

Software UML

UML is a standard language used to document, design, and model software systems. UML provides a standardized and structured graphical notation to describe elements in a system, relationships between elements, and system behavior. The design of UML modeling in this application aims to define Prototyping, make analysis and design, and describe architecture in object-oriented programming. The following is the UML in the application system that will be designed based on user needs:

a. Diagram *Use Case*

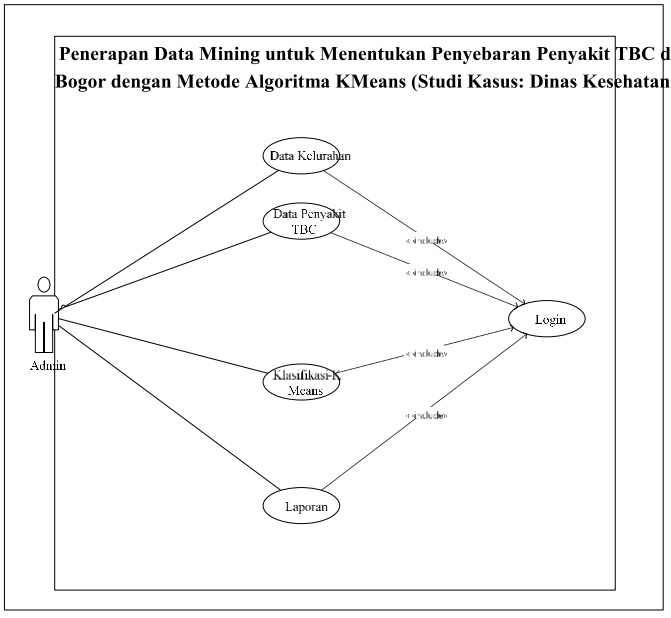


Figure 1. Use Case Diagram

The use case diagram above illustrates the interaction between the system and the external actor involved, Admin. Admin can manage all data stored in the database in the system.

b. Activity Diagram

Activity Diagram Login

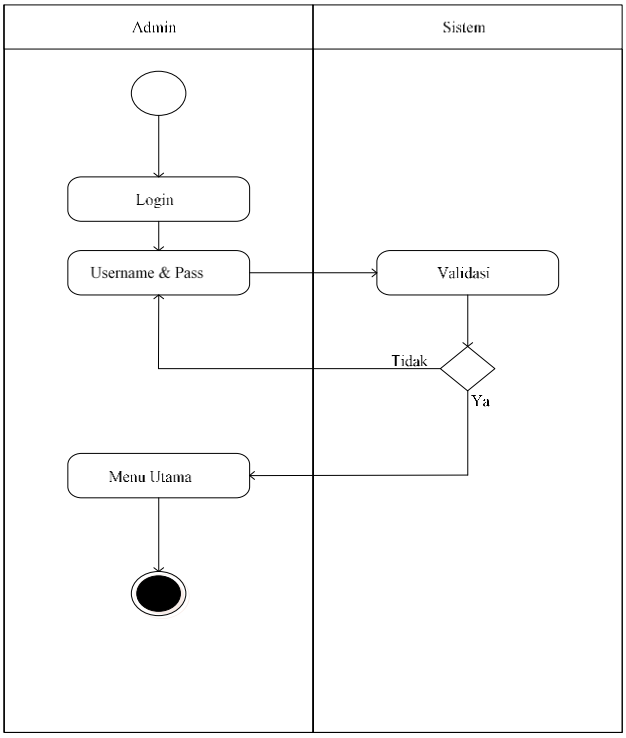


Figure 2. Activity Diagram Login

Based on the image above, it can be explained about the admin's access rights to the system. The admin logs in first which will then be validated by the system according to the data in the database. If the data is valid, the admin will be directed to the main page (home). On the main page (home) some menus can be accessed by the admin. The admin can perform the data input process, reset data, and delete data. The data will be saved to the database after being validly managed by the admin.

Diagram *Activity* Penyakit TBC

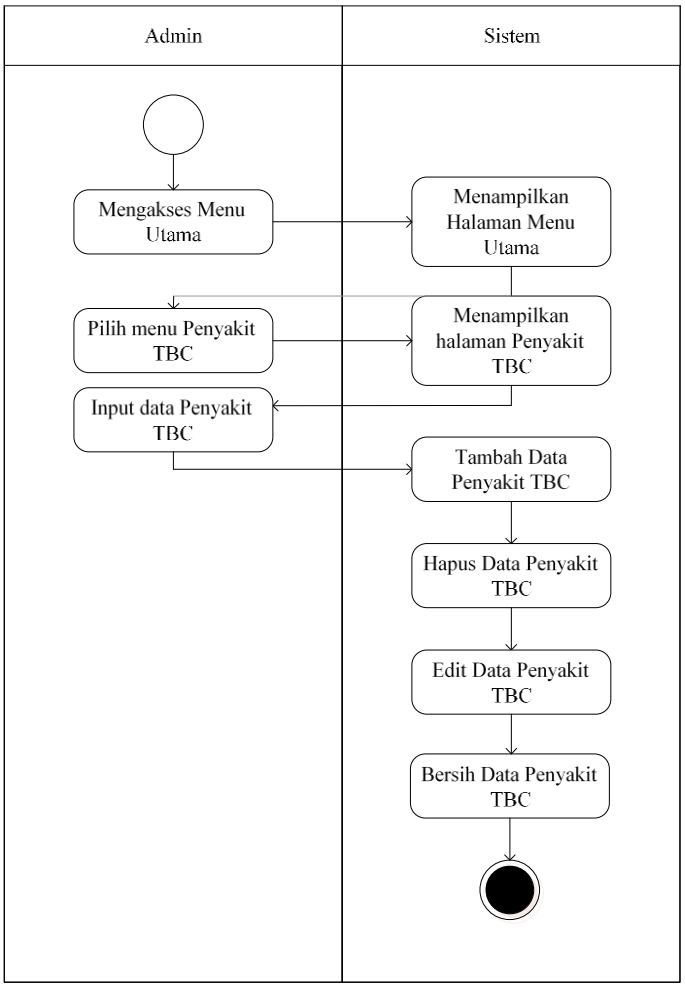


Figure 3. *Activity* Diagram Penyakit TBC

Based on the image above, it can be explained about the admin's access rights to the system. The admin logs in first which will then be validated by the system according to the data in the database. If the data is valid, the admin will be directed to the main page (home). On the main page (home) some menus can be accessed by the admin. The admin can perform the data input process, reset data, and delete data. The data will be saved to the database after being validly managed by the admin.

Activity Data Diagram of Sub-district

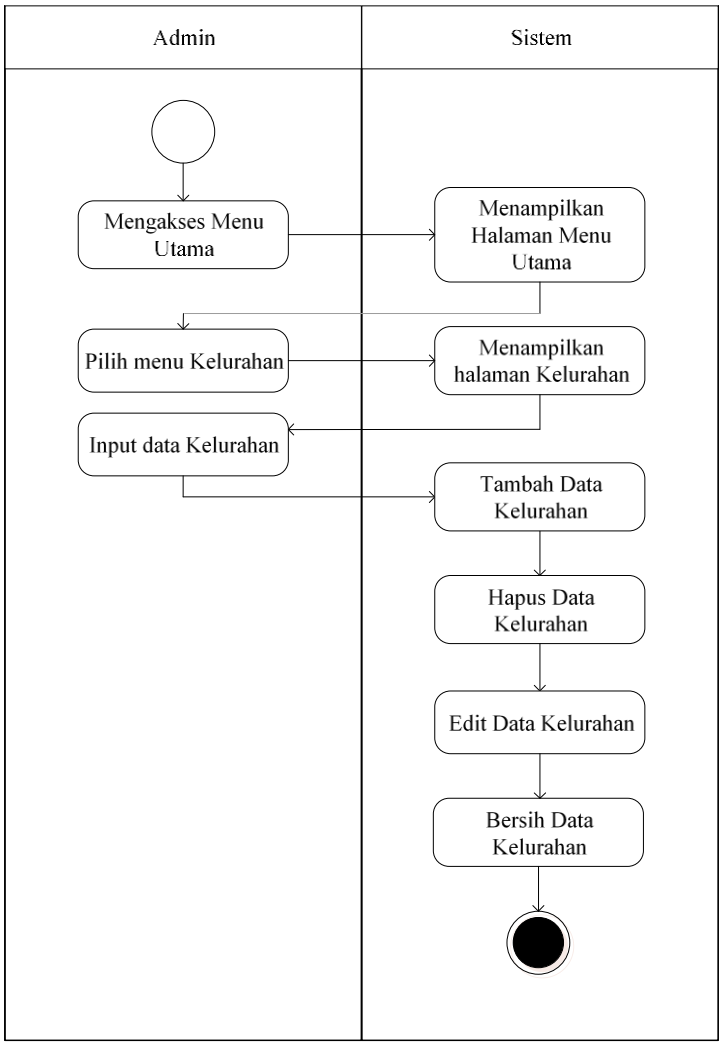


Figure 4. Activity Data Diagram of Sub-district

Based on the image above, the admin will be directed to the main page (home), and then to the village data menu page. The admin can perform the data input process, reset data, and delete data. The data will be saved into the database after being valid.

Activity Data Classification Diagram

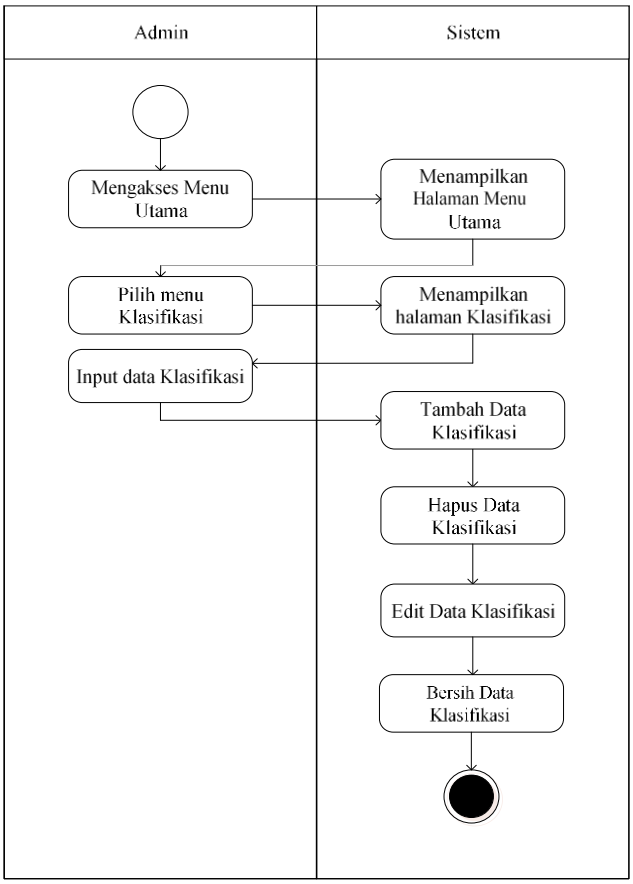


Figure 5. Activity Data Classification Diagram

Based on the image above, you will be directed to the main page (home), and then to the Classification data menu page. Admin can perform the data input process, reset data, and delete data. Data will be saved into the database after validation.

Activity Report Diagram

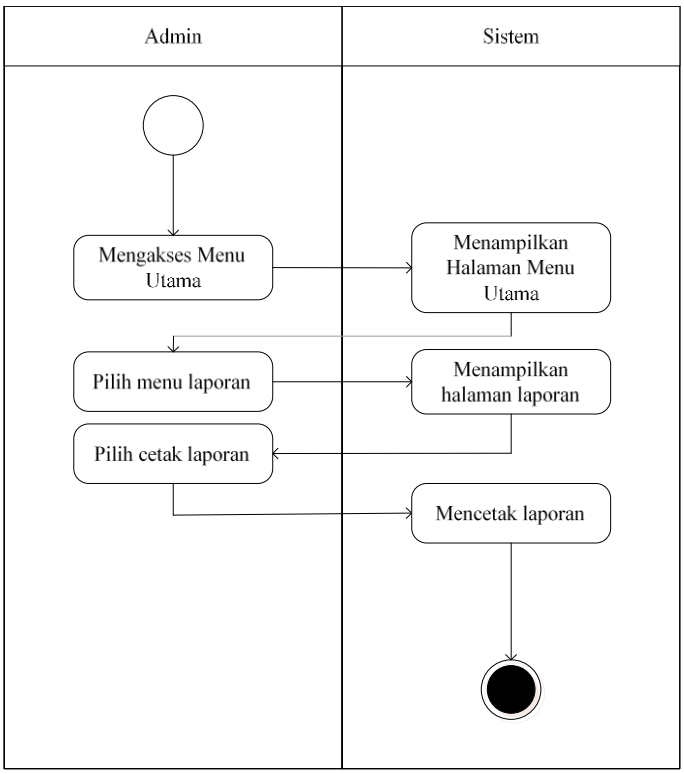


Figure 6. Activity Report Diagram

Based on the image above, it will be directed to the main page (home), and then to the Report menu page. Admin can perform the data input process, reset data, and delete data. Data will be saved into the database after being valid.

c. Sequence Diagram

Sequence Diagram Login

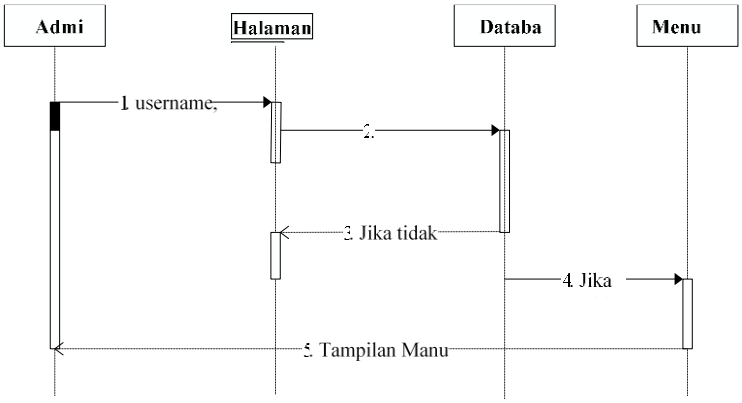


Figure 7. Sequence Diagram of TBC

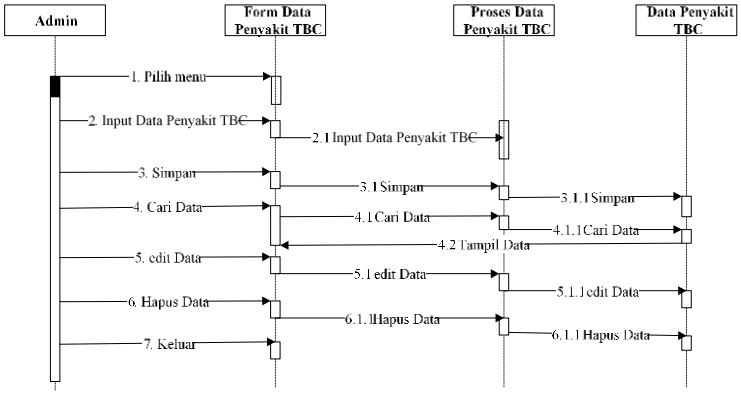


Figure 8. Sequence Diagram of Sub-district

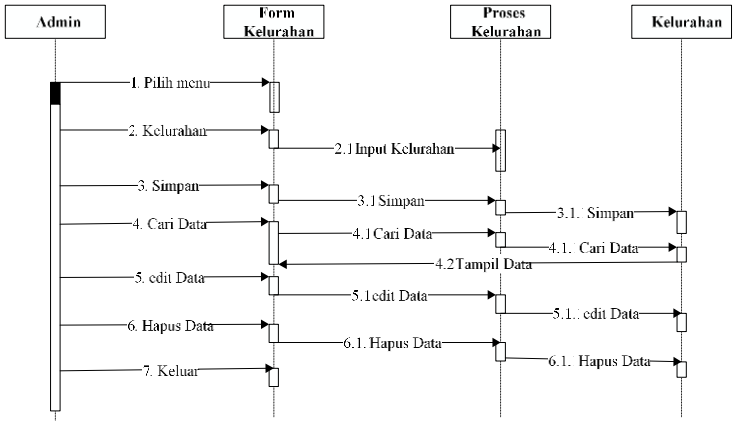


Figure 9. Sequence Diagram Data Classification

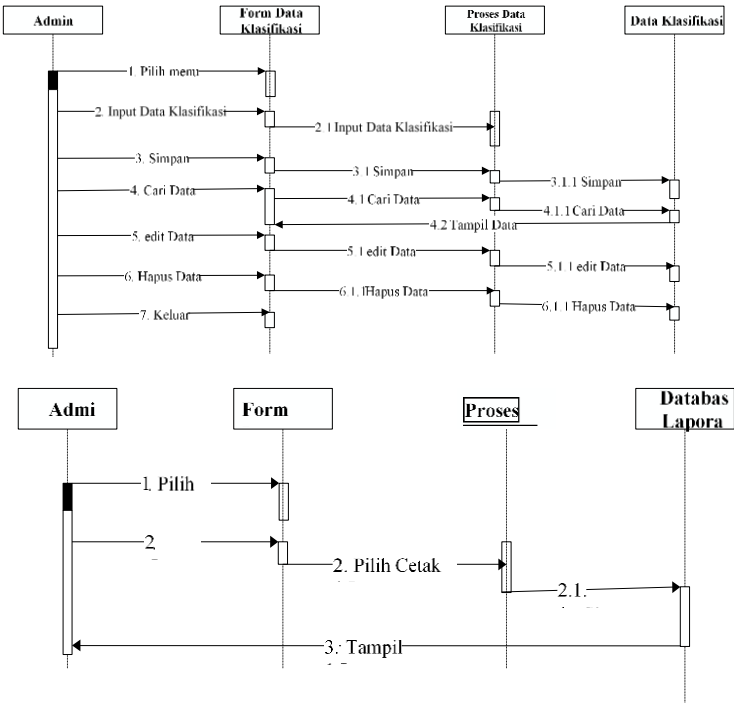


Figure 10. Report Data Sequence Diagram

Screen Display

Figure 11. Admin login screen view

The display above is the login screen display, there is a username and password that must be entered. The system will validate the username and password, if valid then enter the main menu, if not valid then it will remain in the login menu. The user interface display of an application used to implement data mining in determining the spread of TB (Tuberculosis) in Bogor Regency. This application uses the K-Means algorithm method, which is one of the clustering algorithms in data mining.

Figure 12. Main Menu Screen View

The display above is the main menu screen display. There are 5 menus in the form of Village Data, TB Disease Data, KMeans Classification, Reports, and logout. This display shows the main interface display of the application used to analyze the spread of TB (Tuberculosis) cases in Bogor Regency using the K-Means algorithm method.

Figure 13. Village Data Menu Screen Display

The display above is a display of the sub-district data menu screen. Some data must be inputted, in the form of ID, Sub-district Code, Sub-district Name, and Number of Residents. With this function, the application makes it easier for Health Service officers to monitor the affected population and take preventive or treatment measures as needed based on accurate data.

Figure 14. TB Disease Menu Screen Display

The display above is a display of the TB disease menu screen. Some data must be inputted, in the form of ID, Village Code, Village Name, Anatomy, and Diagnosis Results.

Figure 15. K-Means Classification Menu Screen View

The display above is the display of the K-means classification menu screen. There is data displayed in the form of ID, Village Code, Village Name, and Results.

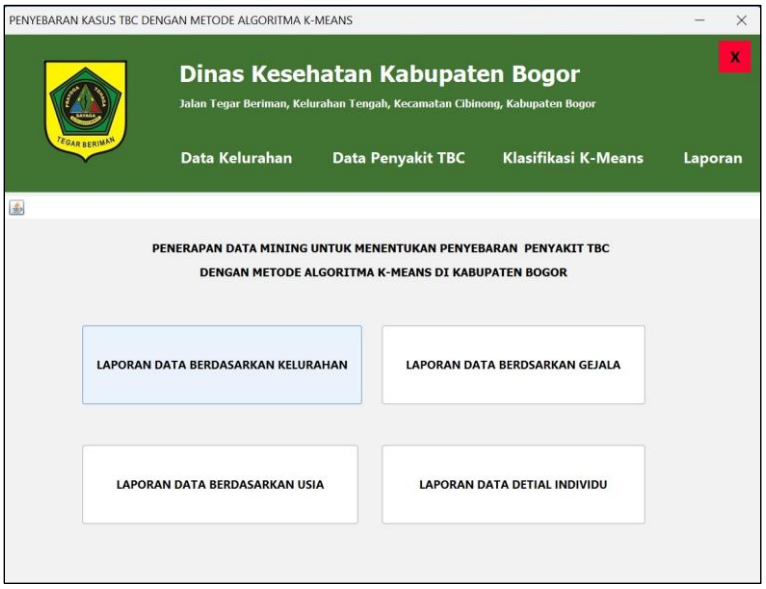
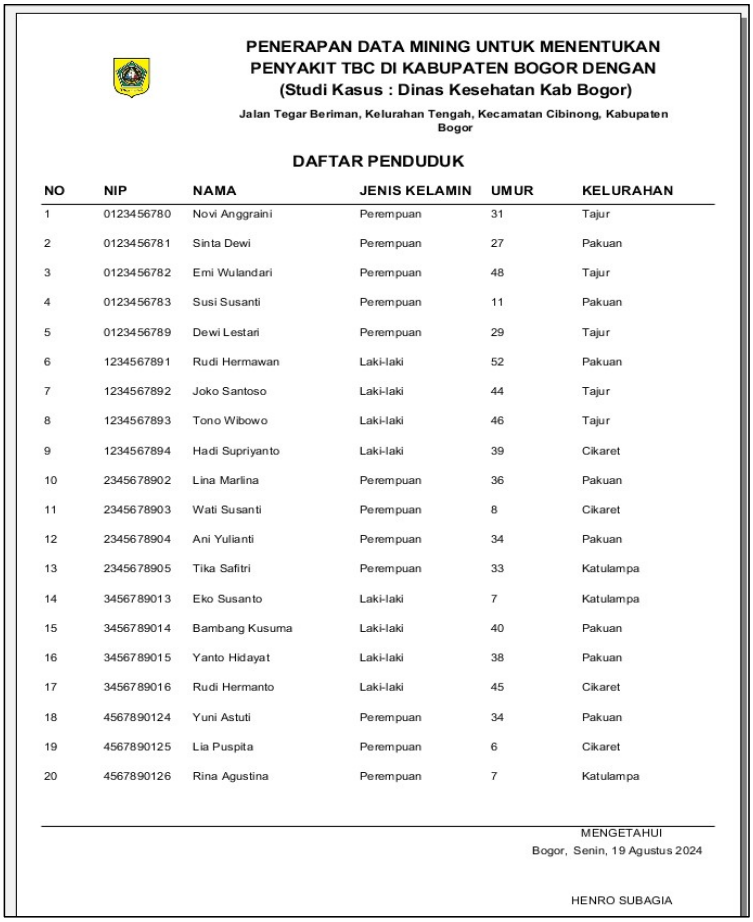


Figure 16. Report Menu Screen Display

The above display is the display of the report menu, there is a button to print the report consisting of, the village report, TB case data report, village data report (High Case), and village data report (Low Case).



PENERAPAN DATA MINING UNTUK MENENTUKAN PENYAKIT TBC DI KABUPATEN BOGOR DENGAN (Studi Kasus : Dinas Kesehatan Kab Bogor)

Jalan Tegar Beriman, Kelurahan Tengah, Kecamatan Cibinong, Kabupaten Bogor

DAFTAR PENDUDUK

NO	NIP	NAMA	JENIS KELAMIN	UMUR	KELURAHAN
1	0123456780	Novi Anggraini	Perempuan	31	Tajur
2	0123456781	Sinta Dewi	Perempuan	27	Pakuan
3	0123456782	Emi Wulandari	Perempuan	48	Tajur
4	0123456783	Susi Susanti	Perempuan	11	Pakuan
5	0123456789	Dewi Lestari	Perempuan	29	Tajur
6	1234567891	Rudi Hermawan	Laki-laki	52	Pakuan
7	1234567892	Joko Santoso	Laki-laki	44	Tajur
8	1234567893	Tono Wibowo	Laki-laki	46	Tajur
9	1234567894	Hadi Supriyanto	Laki-laki	39	Cikaret
10	2345678902	Lina Marlina	Perempuan	36	Pakuan
11	2345678903	Wati Susanti	Perempuan	8	Cikaret
12	2345678904	Ani Yulianti	Perempuan	34	Pakuan
13	2345678905	Tika Safitri	Perempuan	33	Katulampa
14	3456789013	Eko Susanto	Laki-laki	7	Katulampa
15	3456789014	Bambang Kusuma	Laki-laki	40	Pakuan
16	3456789015	Yanto Hidayat	Laki-laki	38	Pakuan
17	3456789016	Rudi Hermanto	Laki-laki	45	Cikaret
18	4567890124	Yuni Astuti	Perempuan	34	Pakuan
19	4567890125	Lia Puspita	Perempuan	6	Cikaret
20	4567890126	Rina Agustina	Perempuan	7	Katulampa

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Figure 17. Display of Population Data Report by Sub-District

The display above is the display of the village data report, displaying data in the form of codes, village names, and the number of residents.

Figure 18. TB Case Data Menu and Report Display Based on Symptoms

It contains a menu for a selection of population data affected by tuberculosis in Bogor Regency. This menu is designed to monitor and analyze the spread of Tuberculosis (TB) in Bogor Regency. Through this menu, users can access different types of reports that help in quick and precise decision-making.

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NO	NIP	NAMA	JENIS KELAMIN	UMUR	KELURAHAN	GEJALA
1	0123456782	Emi Wulandari	Perempuan	48	Tajur	ringan
2	0123456783	Susi Susanti	Perempuan	11	Pakuan	ringan
3	1234567891	Rudi Hermawan	Laki-laki	52	Pakuan	ringan
4	3456789015	Yanto Hidayat	Laki-laki	38	Pakuan	ringan
5	5678901235	Firman Pratama	Laki-laki	6	Baranangsiang	ringan
6	5678901237	Iwan Setiadi	Laki-laki	49	Cikaret	ringan
7	5678901238	Dedi Kurniadi	Laki-laki	36	Katulampa	ringan
8	6789012348	Lusi Handayani	Perempuan	3	Baranangsiang	ringan
9	7890123456	Agus Prasetyo	Laki-laki	19	Cikaret	ringan
10	8901234567	Maya Indah	Perempuan	33	Baranangsiang	ringan
11	8901234568	Rina Fitriani	Perempuan	26	Baranangsiang	ringan
12	9012345672	Andi Saputra	Laki-laki	4	Baranangsiang	ringan

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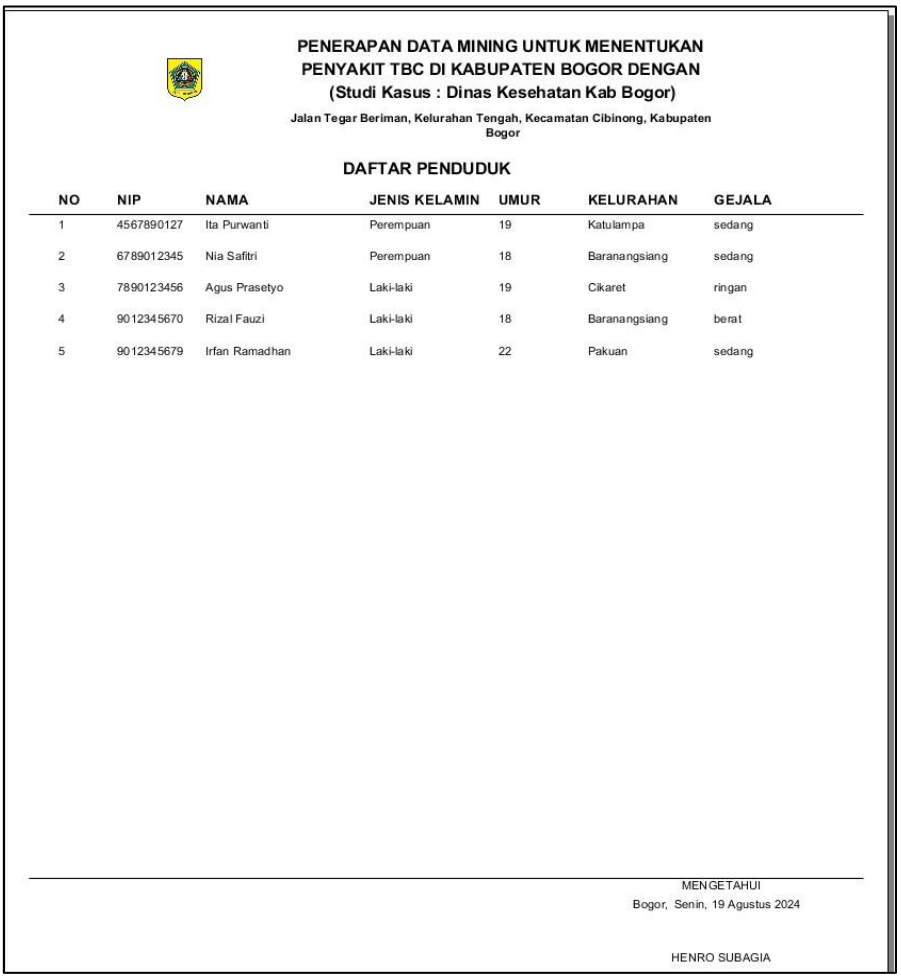
Figure 19. TB case data report menu, in the form of codes, village names, anatomy, and diagnosis.



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NO	NIP	NAMA	JENIS KELAMIN	UMUR	KELURAHAN	GEJALA
1	4567890127	Ita Purwanti	Perempuan	19	Katulampa	sedang
2	6789012345	Nia Safitri	Perempuan	18	Baranangsiang	sedang
3	7890123456	Agus Prasetyo	Laki-laki	19	Cikaret	ringan
4	9012345670	Rizal Fauzi	Laki-laki	18	Baranangsiang	berat
5	9012345679	Irfan Ramadhan	Laki-laki	22	Pakuan	sedang

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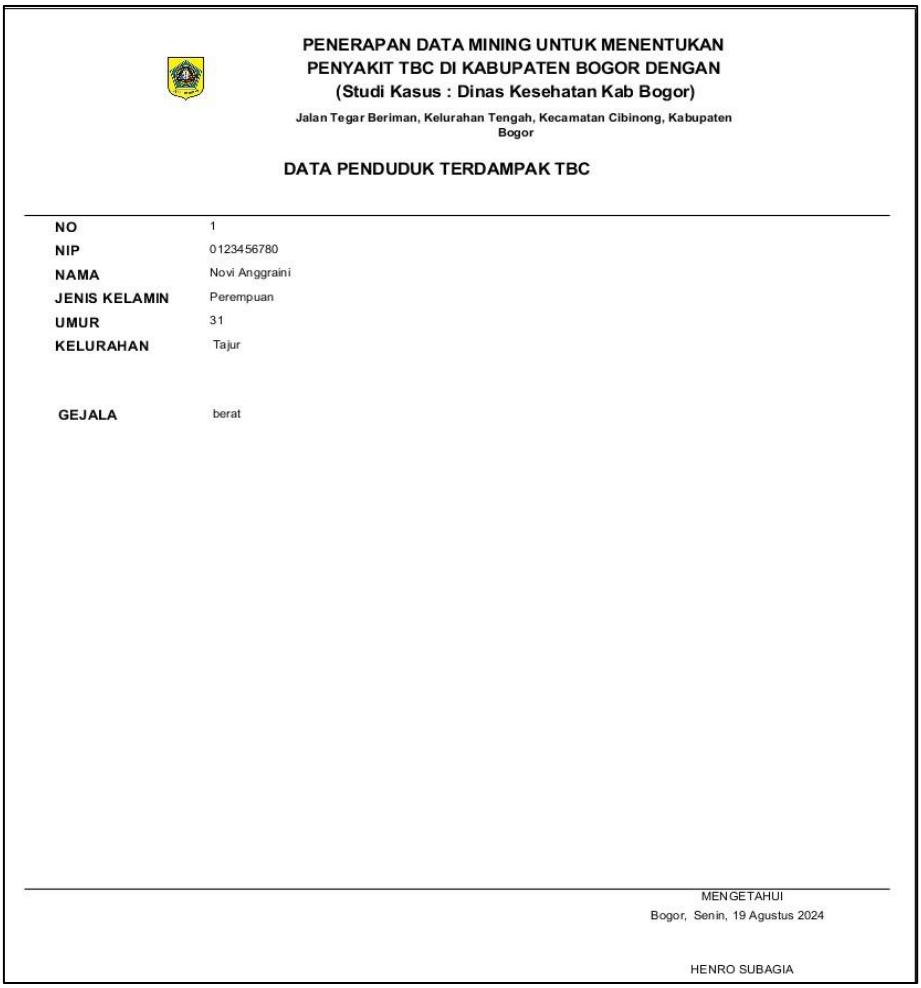
Figure 20. TB Data Report View Based on Age

The display above is the display of the Sub-district Data (High Case) report menu, displaying data in the form of Sub-district Code and Sub-district Name.



PENERAPAN DATA MINING UNTUK MENENTUKAN
PENYAKIT TBC DI KABUPATEN BOGOR DENGAN
(Studi Kasus : Dinas Kesehatan Kab Bogor)

Jalan Tegar Beriman, Kelurahan Tengah, Kecamatan Cibinong, Kabupaten Bogor

DATA PENDUDUK TERDAMPAK TBC

NO	1
NIP	0123456780
NAMA	Novi Anggraini
JENIS KELAMIN	Perempuan
UMUR	31
KELURAHAN	Tajur
GEJALA	berat

MENGETAHUI
Bogor, Senin, 19 Agustus 2024

HENRO SUBAGIA

Figure 21. TB Data Report View Details

The display above is the display of the Sub-district Data (Low Case) report menu, in the form of Sub-district Code and Sub-district Name.

4. CONCLUSION

The conclusions that the author can present in this final project with the existence of an application system in the application of data mining to determine the spread of tuberculosis disease in Bogor Regency with the K-Means Algorithm include: (1) The

application system in determining the spread of tuberculosis disease with the K-Means method uses Java and MySQL programming languages as the database. (2) The K-Means algorithm can be used to group areas in Bogor Regency based on the characteristics of TB spread. For example, regions with high rates of TB cases can be grouped into one cluster, while low ones into another. (3) The K-Means algorithm can help monitor changes in TB spread patterns over time. By updating the data periodically, it is possible to evaluate the success of the intervention programs that have been carried out.

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