 ISBN: 978-623-92207-1-6

Clinical Decision Support System for Mapping of Blood Pressure and Heart Rate

1st Sri Sumarlinda
Information System Department, Faculty of Computer
Duta Bangsa University of Surakarta
Surakarta, Indonesia
sri_sumarlinda@udb.ac.id

2nd Wiji Lestari
Information System Department, Faculty of Computer
Duta Bangsa University of Surakarta
Surakarta, Indonesia
wiji_lestari@udb.ac.id

***Abstract*—Blood pressure has influence on cardiovascular diseases. This study aims to develope clinical decision support system (CDSS) model which non rule based system. The model eas improved using data mining function, especially clustering. K-Means algorithm was used to clustering 120 data and 4 attributes{ age, obesity, sistolic, diastolic and heart rate The clustering process used 500 epoches and 3 cluster. The result of clustering produced 3 cluster. Cluster 1 is higher risk, cluster 2 is medium risk and cluster 3 is normal or lower risk.**

***Keywords*—blood pressure, heart rate, clinical decision support system (CDSS), clustering, K-Means algorithm**

I. INTRODUCTION

The human blood pressure is very important in life to be kept at a normal threshold [1], [2], [3]. Blood pressure is called the silent killer, considering that hypertension is a risk factor for cardiovascular disease. The blood pressure is the force needed for blood to flow in the blood vessels and circulating to all tissues of the human body. The blood that circulates smoothly throughout the body has a very important function as a medium for carrying oxygen and substances needed by body cells. In addition, blood also functions as a means of transporting useless metabolic waste [2], [3], [4], [5], [6]. Human blood pressure can be divided into systolic blood pressure and diastolic blood pressure. Systolic blood pressure is when the heart is closed (systole) and diastolic blood pressure is when the heart relaxes again (diastole), so the diastolic pressure is always lower than systolic blood pressure [1], [4], [5], [7]. Factors that affect high blood pressure (hypertension) are age, genetics, lifestyle, lack of exercise, obesity and others. Human blood pressure is categorized into low blood pressure (hypotension), normal blood pressure (normotension) and high blood pressure (hypertension) [8], [9]. According to the WHO classification of blood pressure and heart rate as in table 1 and table 2 below:

Table 1. Classification of Blood Pressure

No	Systolic (mmHg)	Diastolic (mmHg)	Classification
1	< 90	< 60	Hypotension
2	90 - 140	60 – 90	Norm tension
3	141 - 159	91-94	Borderline Hypertension
4	>160	>95	Hypertension

Table 2. Classification of Heart Rate

No	Value of Heart rate (bpm)	Classification
1	< 60	Bradycardia
2	60 - 100	Normal
3	>100	Tachycardia

The development of computing model in the health field is growing rapidly. The decision support system as a computing paradigm has contributed to the clinical field with the emergence of a clincal decision support system (CDSS) [6], [10]. Clinical Decision Support System (CDSS) is a new paradigm that combines clinical systems and decision support systems. The application of CDSS in the medical field is important in small and large scale. CDSS is implemented to improve health services. CDSS is incorporated into health care activities and processes, the potential for change in approach and benefits will continue to grow [11], [12]. CDSS is a computer application designed to assist healthcare professionals with making clinical decisions about individual patients. CDSS provides assistance in clinical decision making and therefore needs to consider human functioning, data interactions, and the cognitive of clinical decision makers. The processes in the CDSS include information flow, use, and share characteristics in the hospital setting, and then describe the referential context for the model, which is clinical decisions in the hospital setting. Computer-based decision support systems can play an important role in accurate and timely diagnosis. Data mining is a computational field that is concerned with selecting and extracting data to produce information and knowledge [11], [13]. There are several data mining functions such as prediction, estimation, classification, clustering and association. The development of CDSS also integrates data mining functions to improve performance [14],[15], [16].

The Mapping is a technique used to identify similar objects or individuals by taking into account several criterias. The Mapping is a grouping with certain references. Clustering is a method for grouping elements that are similar as research objects into distinct and mutually exclusive clusters [16], [17], [18]. Another definition is an effort to find a group of objects that represent a character that is the same or almost the same (similar) between one object with other objects in a group and has a difference (not similar) with objects in other groups [17], [18].

In this study, a CDSS model was developed for mapping blood pressure and heart rate based on data mining, especially clustering using the K-Means algorithm. The purpose of this study is to build a CDSS with more performance based on data mining with a clustering function using the K-Means algorithm. The contribution of this study is the mapping of blood pressure and heart rate for individuals and communities. Mapping is useful for policy and further decisions in the health sector.

II. METHOD

This study used a research and development approach. This study used 4 attributes, namely age, obesity, systolic blood pressure, diastolic blood pressure and heart rate. The variables of input variables were processed by K-Means clustering algorithm. The number of data input were used in this research 120 respondents.

A. Research Stages

The stages of research are shown in Fig.1 below:

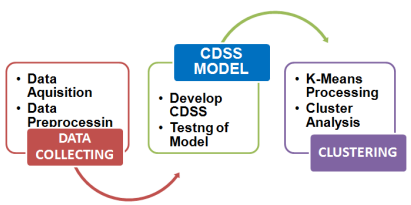

Fig.1. The Stages of Research

ISBN: 978-623-92207-1-6

The research process began with data collecting, with 2 step namely data acquisition and data preprocessing. The next process is developing CDSS model and finally is Clustering process.

Data Collecting
At this stage, the data collection process was carried out. Input data were secondary data from the hospital which is then carried out by preprocessing. Preprocessing included eliminating of missing data and also transforms data so that it can be used for further processing. The number of data input are 120 with 4 attributes.

CDSS Model
At this stage a CDSS model is developed. This model is a non rule based CDSS by using the data mining clustering function approach.

Clustering
The clustering process was the main process in the CDSS model. The clustering process used the K-Means algorithm with 500 epoches and cluster 3. The clustering results are then analyzed.

B. K-Means Clustering Algorithm

The K-Means algorithm is one of the algorithms with the simplest unsupervised learning method that solves the well-known grouping problems. This algorithm procedure follows a simple and easy way to classify certain data sets through a number of clusters (assume j clusters) remain a priori. The main idea is to define centroid j, one for each cluster. These centroids must be placed in a sneaky manner as different ones lead to different results. So, the better option would be to place them as far away from each other as possible [18].

$$d = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^j - c_j \right\|^2 \quad (1)$$

$$c_j^{new} = \frac{1}{n_j} \sum_{i=1}^{n_j} x_{ij} \quad (2)$$

Where:
d = cumulative distance
x = data point
c = cluster centroid
c_j^{new} = new cluster centroid in cluster j
n_j = number of data in cluster j

III. RESULT

The CDSS model used 120 data input with 4 varables. CDSS model was developed non rule based and used K-Means Clustering algorithm. The clustering process used epoches 500 and number of cluter 3. The model was implemented by Rapidminer. The clustering process shown in figure 2 below:

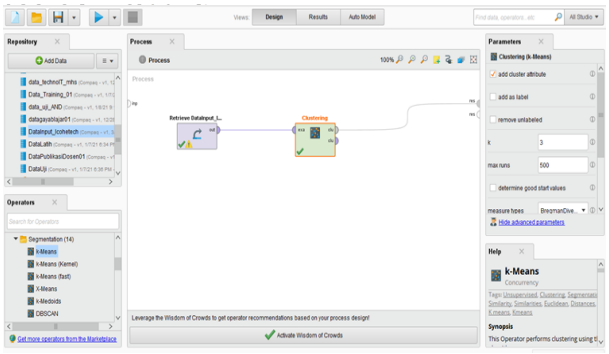

Fig.2. The Clustering Process

The results of processing was produced 3 cluster. Cluster 1 had 5 member (4.16%), cluster 2 had 63 member (52.5%) and cluster 3 had 52 member (43%). The cluster distribution are represented by graph shown in fig 3 below :

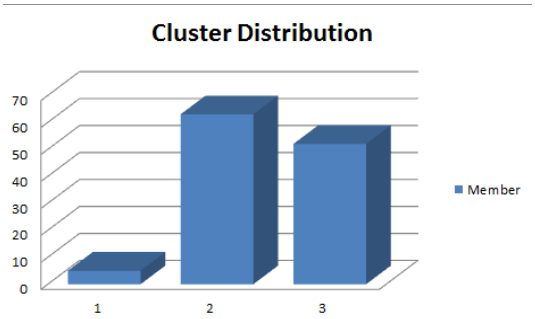

Fig.3. The Cluster Distribution

The centroid of clusters are imporatnt for cluster analysis. The distribution of cluaters centoid shown in table 3 below:

Table 3. Clusters Centoid

Atribute	Cluster 1	Cluster 2	Cluster 3
Age (years)	54.00	48.41	39.04
Obesity	28.22	24.15	22.76
Sistolic (mmHg)	204.80	158.32	116.85
Diastolic (mmHg)	120.60	92.76	77.92
Heart Rate (bpm)	104.40	85.11	69.56

For detaily value of centroid are represented in figure 4. below :

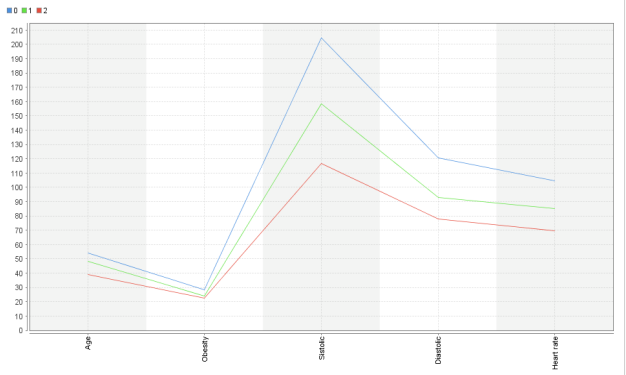

Fig.4. The Centroid of Cluster

According to resul of clustering process, cluster 1 is higher risk or higher state, cluster 2 is medium risk or medium state and cluster 3 is normal or lower risk.

IV. CONCLUSION

The CDSS model which non rule based system was developed. It was improved using data mining function. The function that used was clustering using K-Means algorithm. The number of data input was 120 and 4 attributes. The attributes were age, obesity, sistolic blood pressure, diatolic blood pressure and heart rate. The clustering process used 500 epoches and 3 clusters. The result of clustering produced 3 cluster, Cluster 1 had 5 member (4.16%), cluster 2 had 63 member (52.5%) and cluster 3 had 52 member (43%). The cluster analysis result showed that cluster 1 is higher risk, cluster 2 is medium risk and cluster 3 is normal or lower risk.

ACKNOWLEDGMENT

We would like to thanks Research and Public Service Institution of University of Duta bangsa Surakarta .

REFERENCES

[1] M. Pulido and P. Melin, “Blood Pressure Classification Using the Method of the Modular Neural Networks,” Int. J. Hypertens., vol. 2019, 2019.

[2] B. R. Olin and D. Pharm, “Hypertension : The Silent Killer : Updated JNC-8 Guideline Recommendations,” 2018.

[3] Y. Yano et al., “Association of Blood Pressure Classification in Young Adults Using the 2017 American College of Cardiology/American Heart Association Blood Pressure Guideline With Cardiovascular Events Later in Life,” American Medical Association, vol. 27705, no. 17, pp. 1774–1782, 2018, doi: 10.1001/jama.2018.13551.

[4] T. Minh and N. Minh, “Changes In Blood Pressure Classification , Blood Pressure Goals and Pharmacological Treatment Of Essential Hypertension In Medical Guidelines From 2003 To 2013 IJC Metabolic & Endocrine Changes in blood pressure classi fi cation , blood pressure goals and pharmacological treatment of essential hypertension in medical guidelines from 2003 to 2013,” IJCME, vol. 2, no. March 2014, pp. 1–10, 2015, doi: 10.1016/j.ijcme.2014.01.001.

[5] K. Matsumura, P. Rolfe, S. Toda, and T. Yamakoshi, “Cuffless blood pressure estimation using only a smartphone,” Scientific Report, pp. 1–9, 2018, doi: 10.1038/s41598-018-25681-5.

[6] G. Bacelar, R. Chen, and K. Institutet, “Transforming a High Blood Pressure Clinical Guideline into a CDSS - Difficulties in Understanding TRANSFORMING A HIGH BLOOD PRESSURE CLINICAL Difficulties in Understanding,” no. July 2017, 2012.

[7] H. Koshimizu, R. Kojima, K. Kario, and Y. Okuno, “International Journal of Medical Informatics Prediction of blood pressure variability using deep neural networks,” Int. J. Med. Inform., vol. 136, no. October 2019, p. 104067, 2020, doi: 10.1016/j.ijmedinf.2019.104067.

[8] I. Saini, D. Singh, and A. Khosla, “Classification of RR-Interval and Blood Pressure for Different Postures using KNN Algorithm,” vol. 5, no. 1, pp. 13–20, 2012.

[9] D. Blowey, B. Falkner, and S. S. Gidding, “Clinical Practice Guideline for Screening and Management of High Blood Pressure in Children and Adolescents,” vol. 140, no. 3, 2021.

[10] T. K. J. Groenhof, F. W. Asselbergs, R. H. H. Groenwold, D. E. Grobbee, F. L. J. Visseren, and M. L. Bots, “The effect of computerized decision support systems on cardiovascular risk factors : a systematic review and meta-analysis,” pp. 1–12, 2019.

[11] R. T. Sutton, “An overview of clinical decision support systems : bene fi ts , risks , and strategies for success,” npj Digit. Med., pp. 1–10, 2020, doi: 10.1038/s41746-020-0221-y.

[12] S. Vuppala and C. B. Turer, “Clinical Decision Support for the Diagnosis and Management of Adult and Pediatric Hypertension,” 2020.

[13] G. J. Njie et al., “Clinical Decision Support Systems and Prevention of Cardiovascular Disease,” vol. 49, no. 5, pp. 784–795, 2020.

[14] L. Farrell, “Evaluation of a Computerized Clinical Decision Support System and EHR-Linked Registry to Improve the Management of Hypertension in a Community Health Center.”

[15] R. Anchala, E. Di Angelantonio, D. Prabhakaran, and O. H. Franco, “Development and Validation of a Clinical and Computerised Decision Support System for Management of Hypertension (DSS-HTN) at a Primary Health Care (PHC) Setting,” vol. 8, no. 11, pp. 1–10, 2013, doi: 10.1371/journal.pone.0079638.

[16] R. Anchala, S. Kaptoge, H. Pant, E. Di Angelantonio, O. H. Franco, D. Prabhakaran, "Evaluation of Effectiveness and Cost-Effectiveness of a Clinical Decision Support System in Managing Hypertension in Resource Constrained Primary Health Care Settings: Results From a Cluster Randomized Trial" J Am Heart Assoc. 2015;4: e001213 doi: 10.1161/JAHA.114.001213

[17] W. Lestari and S. Sumarlinda, “Implementation of ArtificialL Neural Network for Clustering of Students Interesting in Computing Fields,” Int. J. MULTI Sci. I, vol. 1, no. 5, pp. 29–33, 2020.

[18] W. Lestari and S. Sumarlinda, “Clustering Model of Lecturers Performa in Publication Using K-Means for Decision Support Data,” Int. J. MULTI Sci. Clust., vol. 1, no. 10, pp. 88–95, 2021.