Determination of Priority Program Area and HIV Case Prediction with Fuzzy Topsis and Exponential Smoothing Method

by Kusworo Adi

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Determination of Priority Program Area and HIV Case Prediction with Fuzzy Topsis and Exponential Smoothing Method

Taufik Kurniawan
Department of Information System
Diponegoro University
Semarang Indonesia

Suryono, PhD, S.Si., M.Si.
Department of Information System
Diponegoro University
Semarang Indonesia

Kusworo Adi, PhD, S.Si., MT.
Department of Information System
Diponegoro University
Semarang Indonesia

ABSTRACT
Strategic planning is very influential on the successful implementation of a program / activity. Strategic planning can be in the form of prioritizing and forecasting the magnitude of the problem as the basis for determining the strategic step either in the allocation of cost and human resources. After the calculation of fuzzy TOPSIS with alternative is nineteen sub districts in Semarang Regency and the decision criteria in the form of the number of people living with HIV and thirteen other supporting criteria then obtained Bandungan District as the first priority. Exponential smoothing method is used to predict the number of people living with HIV in the period 2017 with the value of constant smoothing (α) of 0.61. Selected smoothing constants are obtained from the average Smoothing constants that produce the smallest MSE values in each sub-district. Development can be done with alternative extensions and addition of number of criteria on TOPSIS fuzzy calculation and use of causal forecasting method to replace exponential smoothing method due to HIV transmission depends on several things both quantitative and qualitative.

General Terms
Decision Support System, Forecasting

Keywords
Fuzzy TOPSIS, exponential smoothing, HIV programs, forecasting, decision making, priorities

1. INTRODUCTION

The number of HIV cases in the world cumulatively until the year 2015 of 36.7 million. There were 34.9 million adult HIV cases in adult females (> 15 years) of 17.8 million people and in children (<15 years) of 1.8 million people. In 2015 alone found a new case of 2.1 million people. The HIV case in Indonesia was first discovered in 1987 in Bali Province. To date more than 80% (407 of 507) districts have reported HIV cases. In Indonesia, as of June 2016 there have been cumulative cases of 208,920 people, most of which are found in the productive age group (25 to 49 years). As the case progresses in the world and in Indonesia, Central Java Province also could not be separated from the findings of HIV cases even the order of the five provinces contributing the largest case number. As of June 2016 in Central Java, cumulative cases were recorded totaling 14,690 people [13]. In response to the increasing findings of HIV cases, the Government of Indonesia has formulated various coping policies under the coordination of the AIDS Commission (KPA) established at the national, provincial and district / city levels [24].

Activities coordinated by KPA include strategic planning, implementation of activities and monitoring and evaluation [24].

Activities that play an important role in planning is decision making. Decision-making is a key part of managers' activities. In the planning process, managers decide on organizational goals to be achieved, resources to be used, and who will carry out the task [10]. One of the most sought after methods by researchers in the field of decision-making at a decision support system (DSS) is the fuzzy set and logic first introduced by Lotfi A. Zadeh in 1965 [17]. The application of fuzzy logic among others is presented to diagnose the degradation of feed water heater performance at power plant facilities [15]. Implementation was also conducted to predict epicenter intensity in China [33] and to determine the level of weathering of monuments to temples in Iran [11]. Similar to fuzzy set and logic, TOPSIS method is widely used in several multi-attribute decision making (MADM) models to solve practical decision problems [17]. The TOPSIS method has been used to evaluate financial performance on thirteen companies in Turkey [6]. Utilization of TOPSIS method is also applied to the selection of wind power component [9]. Besides, TOPSIS method is applied to estimate the hidden cost behind the effort of serving the quality of service by health supplier in Morocco [14].

Over time, the combination of fuzzy and TOPSIS methods is widely used in strategy formulation. The TOPSIS fuzzy method helps decision makers to process the strategy formulation and the process of determining the main strategies to be implemented [31]. The TOPSIS fuzzy method has been used to determine the residential area [22]. Fuzzy TOPSIS is also used to determine the location of the warehouse because the location of the warehouse is one of the most important and strategic things in the logistics system [4]. With the analogy of the use of TOPSIS fuzzy method it is necessary to review the possibility of determining priority areas of program implementation as part of strategy determination.

In addition to prioritizing program areas, the forecasting process is part of an effective and efficient strategic planning tool. Many methods can be used in forecasting, one of it is exponential smoothing method [18]. Some research using exponential smoothing forecasting methods, among others is inflation forecasting in Palu City [5], the main power forecasting model of power plant system [23] and forecasting the daily use of natural gas in Sakarya city Turkey [2]. The forecast accuracy depends on the smoothing coefficient [23], which is the subjective value denoted by α and is between $0 \leq \alpha \leq 1$ [20].

Based on the description presented earlier, the formulation of the problem taken in this research is about the application of TOPSIS fuzzy method and single exponential smoothing method in presenting the proposed sequence of program priority areas as well as predictions of the spread of HIV cases displayed in the form of web-based digital maps.

2. FUZZY TOPSIS

Fuzzy logic introduced by prof. Lotfi Astor Zadeh in 1962. Fuzzy logic is a methodology of suitable problem-solving control systems implemented on a variety of systems. Fuzzy logic can be applied to various fields, such as disease diagnostic systems, marketing system modeling, predictive operations research, classification and pattern matching as well as other fields [16]. In classical logic everything is declared to be binary, meaning that it has only two possibilities: yes or no, right, or 'wrong', 'good' or 'bad' and the like. Unlike the case with fuzzy logic, it allows for a value between the two binary conditions, which means that a condition may have two conditions simultaneously but its value depends on the weight of its membership. The membership weight is expressed by a membership function, a curve showing the mapping of data input points into their membership values (often also called membership degrees) that have intervals between 0 and 1. Some popular membership functions are linear representations, triangular curve representation and trapezoid curve representation [17]. The TOPSIS method is one of the methods in decision support systems based on the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution but also has the longest distance from the negative ideal solution. The steps in the TOPSIS procedure are as follows [17] :

1. Determine the decision matrix, which is the matrix of all criteria values of each alternative.
2. Determining a normalized decision matrix. The calculation of normalization is done by dividing each of the criterion values with the square root of the sum of the squares of the criterion values in the same alternative. The calculation is represented by the following formula

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \quad \text{with i = 1, 2, ..., m and j = 1, 2, ..., n}$$

3. Calculate a weighted, normalized decision matrix. The criterion value of the weighted normalized matrix is by multiplying each criterion value by the weight of the criterion that has been determined by the following calculation formula $y_{ii} = w_i r_{ii}$, with i = 1, 2, ..., m and j = 1, 2, ..., n
4. Calculates the matrix of positive ideal solutions and the ideal negative solution matrix. The positive ideal solution matrix is $A^+ = (y_1^+, y_2^+, \dots, y_n^+)$, as for the negative ideal solution matrix is $A^- = (y_1^-, y_2^-, \dots, y_n^-)$, Where : y_j^+ is max y_{ij} , if j is an attribute of gain and min y_{ij} , if j is a cost attribute y_j^- is min y_{ij} , if j is a gain attribute and max y_{ij} , if j is a cost attribute
5. Calculate the distance between the value of each alternative with the ideal positive solution matrix and the ideal negative solution matrix. The distance of each value of the criterion with a positive ideal solution and a negative ideal solution is calculated by the formula:
   Alternative distance A_i with the positive ideal solution is formulated with

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2} \quad ; i = 1, 2, ..., m$$

   Alternative distance A_i with the negative ideal solution is formulated with

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2} \quad ; i = 1, 2, ..., m$$

6. Calculate the preference value for each alternative. The preference value for each alternative is calculated by the formula:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad ; i = 1, 2, ..., m$$

7. Sorting the preference value, the greatest preference value indicates that the alternative has the greatest chance of being selected

3. EXPONENTIAL SMOOTHING

In general, forecast is divided into two categories, namely quantitative forecasting and qualitative forecasting. Quantitative methods can be divided into periodic series and causal methods, whereas qualitative methods can be divided into exploratory and normative methods. One method of quantitative forecasting is the single exponential smoothing method. The main advantage of using smoothing method is its relatively low cost and its cost [18].

Single exponential smoothing method is calculated by the following formula:

$$S_t = \alpha X_t + (1 - \alpha) S_{t-1}$$

Where :

α: is a smoothing parameter with value $0 < \alpha < 1$

X_t: the actual value of the period to - t

S_{t-1}: smoothing value of period to (t - 1)

Forecasting as a value approach certainly contains errors. A good forecast is seen from the small predictor error value measured by mean squared error, mean absolute error and other prediction error measure. The formula of calculating the mean squared error is as follows:

$$MSE = \sum_{t=1}^{n} \left(\frac{(X_t - S_t)^2}{n}\right)$$

Where :

t: observation period

X_t : actual value of the observation period

S_t : value of smoothing observation period

4. DESIGN OF STUDY

In order to present the map of predictive distribution of HIV cases and the determination of the priority areas of the prevention program, in this study, the steps taken are shown in Figure 1.

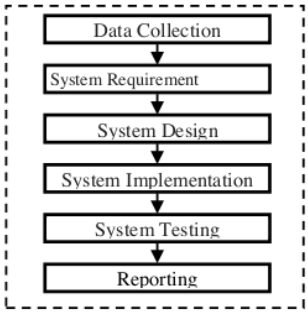

Fig.1 : Research procedure

4.1. Materials Research

Objects used as research material is the HIV cases data in Semarang regency from 2010 until 2016.

4.2. System Framework

A framework that will explain the main components of the system is shown in Figure 2.

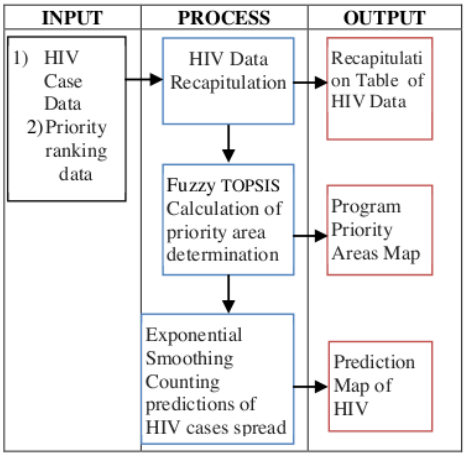

Fig. 2 : System framework

4.3. Use Case Diagram

The actor on the system to be developed consists of admin, manager and officer. It is shown in Figure 3.

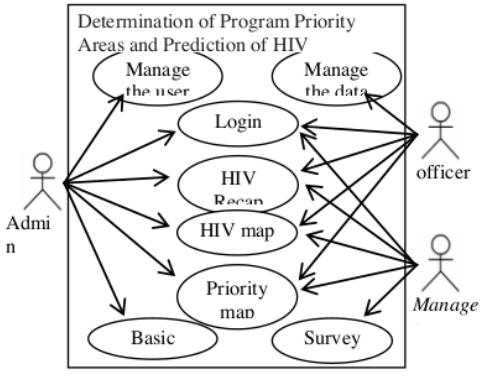

Fig.3 : Use case diagram

4.4. Actifity Diagram

Activity diagrams describe all activities undertaken by each user and each activity are interconnected in determining the program priority areas. The actifity diagram is shown in Figure 4.

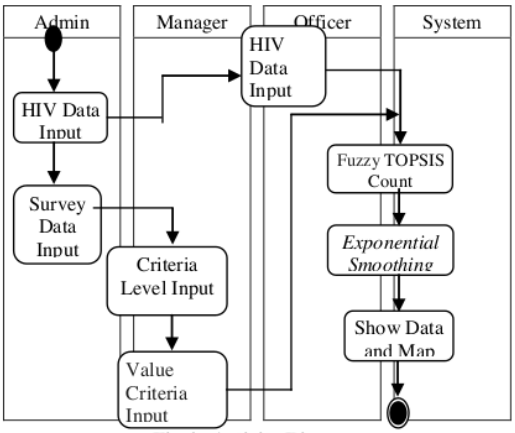

Fig.4 : Activity Diagram

4.5. Class Diagram

The class diagram illustrates the relationship between a group of objects / entities involved in determining the priority areas of the program and predicting the number of sub district HIV cases. The system class diagram is shown in Figure 5.

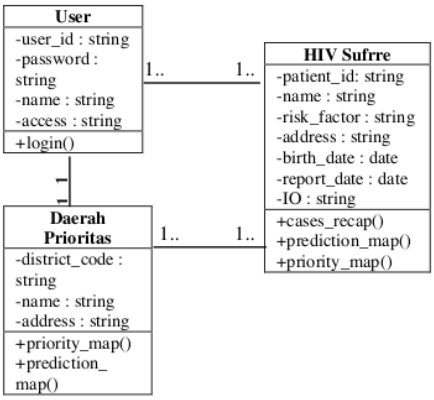

Fig. 5 : Class Diagram

5. RESULTS

5.1. HIV Case Recapitulation

Recapitulation of case distribution is data processing of HIV infected by officer. The menu is shown in Figure 6.

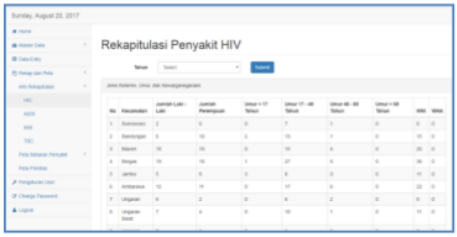

Fig.6 : HIV Data Recapitulation

5.2. The Priority Programe Area Map

To determine the priority area of the program used TOPSIS fuzzy method with alternative choice of priority areas is the sub district area and criteria is a factor of consideration determining the priority area, the priority map of the countermeasures program presented is shown in Figure 7.

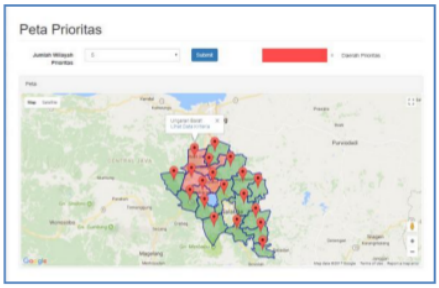

Fig.7 : The Priority Programe Area Map

The result of cumulative preference value calculation becomes the basis of determining the order of preference value from highest to lowest. the order of preference values indicates the order of priority

5.3. The HIV Case Distribution Map

The calculation of prediction data of people with HIV exponential smoothing method is presented in the form of map as shown in Figure 8.

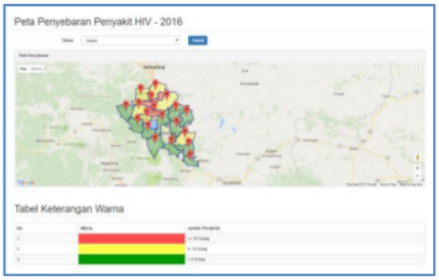

Fig.8 : The Prediction HIV Case Map

The average α is selected, which is 0.61. The mean values of the selected α were used to calculate the predicted spread of HIV cases in 2017.

The Example of HIV case prediction on 2017 in Ambarawa sub district shows that in 2017 it is possible that there will be 5 new cases in the Ambarawa sub-district. The addition of new cases must bring the consequences of the need to prepare various resources to provide optimal services as a series of AIDS prevention in Ambarawa.

6. CONCLUSION

Taking into account the results of research on the application of TOPSIS fuzzy method on the determination of priority areas and exponential smoothing method for prediction of HIV case spread can be summarized as follows:

1. The TOPSIS fuzzy method performs sub-district ranking based on fourteen criteria. Ranking based on the cumulative preference value of the criteria shows that Bandungan Sub-district is the first priority with a cumulative preference value of 6.674952.
2. The prediction of HIV spread prediction depends very much on the selection of the smoothing constant () value which is the average smoothing constant () value with the smallest MSE value in the prediction calculation of all sub-districts using the smoothing () constant value of 0 <<1. In the study obtained value of 0.61 which resulted in the prediction of the addition of HIV cases in Ambarawa as many as 5 people
3. The resulting system succeeded in determining the priority areas of AIDS prevention and prediction of the spread of HIV cases of sub-districts in Semarang Regency with the results displayed on internet-based digital maps

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