Implementation of Hybrid Method of Eckenrode and DIA for the Determination Customer Class

Abdul Kadir¹, Muhammad Syaukani²

¹²Program Studi Teknik Informatika, Universitas Nahdlatul Ulama Kalimantan Selatan, Indonesia
²STIMIK Indonesia Banjarmasin, Indonesia

*kCorrespondent Author

kadir_budiluhur@gmail.com; *syaukani@stmik.id

Abstract. Determination of customer class at the Municipal Waterworks (PDAM) of Balangan Regency so far has been done by calculating each indicator value and criteria that have been surveyed by PDAM officers for potential drinking water customers and the calculation is processed only beside the number of measures assessed, so it takes time and the assessment process. So to avoid dissatisfaction with potential drinking water customers, decision support systems should be used. The purpose of this research is to develop a decision support system for determining the class of drinking water customers using the Eckenrode and DIA methods. The test was conducted as many as 75 data samples to determine the level of accuracy and sensitivity of the system developed, and the results of the experiment showed that the accuracy value was 91%, and the sensitivity value was 93%. The results of this research conclude that the Eckenrode and DIA methods can be applied both in the development of decision support systems for customer classifications.

Keyword : DSS, Customer Class, Eckenrode, DIA

1. Introduction

Water is an essential part of human life. Water is also one of the primary needs of humans and is a prerequisite in measuring the quality of experience in the health context. Every day we need clean water, from drinking, bathing, cooking, washing, and other necessities so that the availability of fresh water in an area is essential to meet a good quality of life. Besides that, water also has a vital role in supporting the prosperity and welfare of the community. The government has implemented a water supply program, both urban and rural, intending to provide services to the city to obtain healthy, clean water for the needs of daily life for economic development and a prosperous community.

The Municipal Waterworks (PDAM) of Balangan Regency as one of the regionally owned business entities under the auspices of the government of Balangan Regency that serves the fundamental needs of the community, namely clean water. For the installation of freshwater, the prospective customer is first determined by the classifications of customers, to be able to determine that the officer from the PDAM must go down to the field and survey or directly review the situation of the prospective customer by conducting interviews directly to the customer to be asked for information and then to calculate in determining the classification baking class. The calculation is carried out utilizing calculating the score value of each prospective customer criteria, in the forecast can be found dissatisfaction by the customer, because of the large amount of potential customer data that cause errors in the calculation
process, to avoid it is necessary to have tools to support the process, namely the decision support system used to assist PDAM officers in calculating the assessment criteria for determining customer classes so that they can produce accurate decisions. Research on the decision support system for the selection of customer groups has been carried out including research [1] on determining the class of drinking water customers in a probability with criteria such as the type of road, road width, kind of house, building type, building area, and parcel. At the same time, the method used is Naïve Bayes. Research [2] defines subsidized and non-subsidized customer tariff groups, while the criteria used are income, housing conditions, and electrical power using Fuzzy Mamdani. Research [3] determining the electric power class of potential customers of PLN. Three main factors are used as criteria, namely the capacity of existing electrical equipment customers, the type of electricity users, and the area. Also, Research [4] determines the best customers with the criteria for total expenditure per three months, the method of payment, length of subscription, and the amount of arrears and uses the TOPSIS method. Whereas the research carried out now is developing a decision support system for the selection of customers of the regional water company, the technique used in the Eckenrode method is used for the process of calculating the weighting criteria and the DIA method is used for the operation of ranking alternative decisions.

2. Research Method
The methodology used in this research uses interviews, document studies, and literature studies. Interviews were conducted to obtain information related to the process of determining the customer group of the regional water company. The meeting was held with the Balangan Regency Municipal Waterworks (PDAM) officer. Study documents are conducted to obtain information on input, output, and research supporting documents. The material required is the procedure for selecting regional water customers. A literature study was conducted to find references to previous research related to the current research and determine the method's application in research.

2.1. Alternative Data and Criteria
Building a decision support system (DSS) required an alternative, criteria, and weight. The results of interviews and documentation studies to the PDAM Balangan District obtained alternative data, criteria, and criteria value scale as follows:

| Code | Alternative       |
|------|------------------|
| A1   | General Social   |
| A2   | Special Social   |
| A3   | Household1       |
| A4   | Household2       |
| A5   | Household3       |
| A6   | Government       |
| A7   | Small Commerce   |
| A8   | Big Commerce     |
Table 2 Criteria and Weight Value

| Code | Criteria                                      | Weight Value |
|------|-----------------------------------------------|--------------|
|      |                                               | 2 | 4 | 6 | 8 |
| C1   | Floor area of the building                    | <=36 M²      | 37-70 M² | 71-130 M² | >130 M² |
| C2   | Surface area                                  | <=70 M²      | 71-120 M² | 121-200 M² | >200 M² |
| C3   | The width of the road                         | <= 2 M²      | 2.1 - 4 M² | 4.1-7 M² | >7 M² |
| C4   | Condition of the building                     | Not Permanent | Semi Permanent | permanent | Luxury home |
| C5   | Electricity usage to PLN                      | No subscribed | 450-900 Watt | 1300 Watt | >= 2200 Watt |

2.2. Eckenrode Method

The Eckenrode method functions to calculate the weight normalization of each criterion whose weight is obtained from the decision-maker. The steps in calculating the weight value using the Eckenrode method, and the equation refers to [5] [6].

2.3. The DIA Method

The Distance to the Ideal Alternative (DIA) method is a method of making decisions based on the ideal alternative Distance to choose the best alternative and provides the best accuracy in identifying alternative ranking. The completion steps using the DIA method, and the equation refers to [7] [8].

3. Results and discussion

The decision-making model for the selection of local water customers is developed using Eckenrode and DIA methods. The Eckenrode method is used to calculate weights, and the DIA is used to complete an assessment of the suitability rating between alternatives and criteria. In completing the decision making, a performance rating matrix is first constructed. For example, if there is a prospective customer will register as a customer of PDAM with data from the survey conducted by the PDAM, namely the name of the potential customer is Ahmad Yani, building floor area = 6 x 6 M², land area = 10 x 15 M², road width = 5 M², Building Condition = Permanent and Electricity Usage = 900 watts, then by referring to table 1 that Alternative A1 is General Social, A2 is Special Social and A3 is Household 1 and so on and Based on table 2 there are five criteria namely C1 is floor area buildings, C2 is the land area, C3 is the width of the road, C4 is the condition of the building and C5 is the use of electricity. Hence, Table 3 shows an alternative performance rating matrix against the criteria.

Table 3 Alternative Performance Rating Matrix against Criteria

| Alternative                | Criteria                      | Floor area of the building (C₁) | Surface area (C₂) | ... | Electricity usage (C₅) |
|----------------------------|-------------------------------|---------------------------------|-------------------|-----|-----------------------|
| A₁ = General Social        |                               | X₁₁                             | X₁₂               | ... | X₁₁₁                  |
| A₂ = Special Social        |                               | ...                             | ...               | ... | ...                   |
| A₃ = Household 1           |                               | X₂₁                             | X₂₂               | ... | X₂₁₁                  |
Referring to Table 2, the $X_{11}$ Value in Table 3 is the score for the General Social alternative to the Building Floor criteria: 2; the $X_{12}$ Value is the score for the General Social alternative to the Land Area criterion that is 2. The same method is used to award all $X_{nm}$ values based on PDAM customer class data; a performance rating matrix is obtained, as shown in Table 4.

Table 4. Performance Rating Matrix

| Alternative | C1 | C2 | C3 | C4 | C5 |
|-------------|----|----|----|----|----|
| A1          | 4  | 2  | 4  | 4  | 4  |
| A2          | 4  | 4  | 4  | 4  | 4  |
| A3          | 2  | 2  | 4  | 2  | 4  |
| A4          | 4  | 4  | 4  | 4  | 4  |
| A5          | 4  | 4  | 6  | 6  | 6  |
| A6          | 4  | 4  | 4  | 6  | 6  |
| A7          | 2  | 2  | 4  | 6  | 6  |
| A8          | 2  | 4  | 4  | 6  | 6  |

Based on Table 6 above, there are two stages to completing the DSS process in this study, namely: 1). weighting stage with the Eckenrode method; and 2). ranking stages of alternative decisions with the DIA Method This stage will be described as follows:

3.1. Weighting Stages with the Eckenrode Method

Based on the data of a prospective customer who registers as a PDAM customer, the weighting value of the potential customer's criteria is obtained by referring to Table 2, so that the criteria weight value is collected and the weight value calculation process is performed using the Eckenrode method. The results are used for alternative ranking decision processes in the weighted normalized matrix value calculation stage and can be seen in table 5.

Table 5 Criteria Weight Value

| Criteria | Weigt Value | Eckenrode Calculation Results |
|----------|-------------|------------------------------|
| C1       | 2           | 0.0833                       |
| C2       | 6           | 0.2500                       |
| C3       | 6           | 0.2500                       |
| C4       | 6           | 0.2500                       |
| C5       | 4           | 0.1667                       |
| Score    | 1           | 1                             |

3.2. Alternative Ranking Stages of Decisions using the DIA Method

Based on Table 4, performance rating matrices that the alternative ranking process of this decision is solved using the DIA method, which is integrated with the calculation of the value of criteria weights by the Eckenrode of the technique. The steps of the alternative decision ranking process are as follows:

1. Calculate the normalization value using the data in Table 6, and the results of these calculations can be seen in the following table 6:
2. Calculating the weighted normalization value using the data in tables 5 and 6, and the results of these calculations can be seen in Table 7:

| Weighted Normalization Matrix |
|-------------------------------|
| 0.0348 0.0521 0.0822 0.0714 0.0462 |
| 0.0348 0.1043 0.0822 0.0714 0.0462 |
| 0.0174 0.0521 0.0822 0.0357 0.0462 |
| 0.0348 0.1043 0.1233 0.1071 0.0693 |
| 0.0348 0.1043 0.0822 0.1071 0.0693 |
| 0.0174 0.0521 0.0822 0.1071 0.0693 |
| 0.0174 0.1043 0.0822 0.1071 0.0693 |

3. Determine the value of a positive ideal solution and a negative ideal solution. Positive ideal solutions and negative ideal solutions can be calculated based on the weighted normalization value using the data in table 7, and the results of these calculations can be seen in the following table 8:

| Value positive and negative ideal solutions |
|---------------------------------------------|
| A⁺  = 0.0348 0.1043 0.1233 0.1071 0.0693 |
| A⁻  = 0.0174 0.0521 0.0822 0.0357 0.0462 |

4. Calculate the distance between each alternative with a positive ideal solution and a negative ideal solution using the data in tables 7 and 8. The results of the calculation can be seen in Table 9 below:

| Distance Calculation Results |
|------------------------------|
| D⁺   | D⁻   |
| 0.1521 | 0.0531 |
| 0.0999 | 0.1052 |
| 0.2051 | 0.0000 |
| 0.0999 | 0.1052 |
5. Based on table 9 determined positive alternative alternatives (PIA)

\[ PIA = \begin{pmatrix} 0.0000 \\ 0.2051 \\ 0.0411 \\ 0.1640 \\ 0.1106 \\ 0.0945 \\ 0.0585 \\ 0.1467 \end{pmatrix} \]

6. Based on the PIA value, an alternative distance calculation of the PIA is carried out, and the results of the calculation can be seen as follows:

\[ \begin{align*}
R1 & = 0.0751 \\
R2 & = 0.1488 \\
R3 & = 0.0000 \\
R4 & = 0.1488 \\
R5 & = 0.2901 \\
R6 & = 0.2320 \\
R7 & = 0.1337 \\
R8 & = 0.2074
\end{align*} \]

Then the alternative chosen as an alternative decision is the highest value = 0.2901, including the customer class: Household3 (R5). Based on the test results using 75 data samples obtained from the Balangan District PDAM, the test results are obtained, as shown in table 10.

| Reality | Amount |
|---------|--------|
| SU      | 18     |
| SKH     | 2      |
| RT1     | 0      |
| RT2     | 0      |
| RT3     | 0      |
| IP      | 0      |
| NK      | 0      |
| NB      | 0      |

| DSS     | Amount |
|---------|--------|
| SU      | 20     |
| SKH     | 2      |
| RT1     | 10     |
| RT2     | 2      |
| RT3     | 12     |
| IP      | 10     |
| NK      | 5      |
| NB      | 6      |

| Total   | 75     |

Based on Table 10, the calculation process is done using a confusion matrix to determine the value of sensitivity, specificity, and accuracy. Then it produces a sensitivity value of 93% and an accuracy value of 91%.
4. Conclusion

Based on research that has been done that the decision support system for determining customer groups is used as a tool to provide solutions to the problem of decision making at the Balangan Regency PDAM using the Eckenrode and DIA Methods. The Eckenrode method is used for the stage of normalization of weight values, and the DIA Method is used for the alternative decision ranking process stages. The results of this research test show that the accuracy value is 91%, and the sensitivity value is 93%, so it can be concluded that the decision support system can be applied in determining the class of customers of the Municipal Waterworks.

5. References
[1]. Junaidi Noh, 2019, Penerapan Metode Naive Bayes Untuk Penentuan Golongan Pelanggan Air Minum Pada Perusahaan Daerah Air Minum (Study Kasus Pada PDAM Ake Ga’ale Ternate), Dintek, 68-75.
[2]. Adi Widarma, Hana Kumala, 2018, Sistem Pendukung Keputusan Dalam Menentukan Pengguna Listrik Subsidi Dan Nonsubsidi Menggunakan Metode Fuzzy Mamdani (Studi Kasus : PT. PLN Tanjung Balai), Jurnal Teknologi Informasi, 165-171.
[3]. Sifa Fauziah, Sri Muryani, 2019, Decision Support System Untuk Menetapkan Daya Listrik Bagi Pelanggan PLN, Persektif, 22-27.
[4]. M. Abu Jihad Plaza R, 2019, Pemanfaatan Metode Technique For Order Preference By Similiarity To Ideal Solution (TOPSIS) Untuk Menentukan Pelanggan Terbaik, Jurnal Informasi Dan Komputer, 1-8.
[5]. Saaty, T.L.. Decision Making For Leaders, Forth edition. University of Pittsburgh: RWS Publication. 2001.
[6]. Syaukani M, Hartati S, Kusnanto H., Guritno S 2019 Modeling on clinical group decision support system for screening and working diagnosis acute respiratory infections TICATE 2018 IOP Conf. Series: Materials Science and Engineering 508 pp1-8.
[7]. Mohamed Lahby, Leghris Cherkaoui and Abdellah Adib, 2012, New Multi Access Selection Method Based on Mahalanobis Distance, Applied Mathematical Sciences, 2745–2760.
[8]. P.N. Tran and N. Boukhatem, 2008, The distance to the ideal alternative(DiA) algorithm for interface selection in heterogeneous wireless networks, Proceedings of The 6th ACM international symposium on Mobility management and wireless access (MobiWac’08), 61-68.