Promethee: As a supporting decision of selection of poor rice receivers

by Muhammad Yunus

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A B Maulachela[1], S Hidayat[1], N Fitriani[1], A A Rizal[1], J Budiarto[1], A S Anas[1], G S Nugraha[1], A Juliansyah[1], J Qudsi[1], Abdurahim[1], M Yunus[1], N K Sriwinarti[1]

[1]Informatic Engineering, STMIK Bumi Gora Mataram, Ismail Marzuki Street, Mataram, Indonesia.

Email:adam.bachtiar@stmikbumigora.ac.id

Abstract. The issue of poverty, for the Indonesian government, has become a serious problem and a major concern to be solved immediately. One way is to ensure affordable food for low-income people. Therefore, increasing the sovereignty of food as a realization of the 7th of NAWACITA 2015-2019 needs to be strengthened. It can be realized by increasing staple food production and maintaining the stability of food prices. The subsidized rice program is one way to achieve this. To run well, the Coordinating Ministry for Human Development and Culture (Menko PMK) is responsible for coordinating, synchronizing and controlling the implementation of the program. Unfortunately, the implementation of this program has drawn much criticism from the public. The allocation and distribution process of wrongly targeted rice is one of them. Therefore, a system that can provide decision support in determining the recipients of subsidized rice is needed. This paper used PROMETHEE as its decision support method. First is a determination of alternatives, i.e., the prospective recipients of subsidized rice. Then specify criteria and preference types for each criterion. Only the usual type of preference implemented in this study. Next is calculating the preference value and index, then determining the direction of preference, and the last stage is validation. The result obtained from this research is the rank of recipients of subsidized rice, namely List of Beneficiary Target Household (LBTH).

1. Introduction

According to data from the Indonesian Central Bureau of Statistics (BPS), the number of poor people in Indonesia as of September 2017 decreased to 10.12% from the previous 10.64%[1]. This number can be obtained because of poverty alleviation programs implemented by the Indonesian government, one of them is Poor Rice Program (Raskin Program). This program has been running from July 1998 until now [2].

In its implementation, the Raskin Program was carried out by the lowest ranks of government, namely village chief and village head. Determination of beneficiaries is still done manually, namely by holding a meeting between village head and all village chiefs in the village [3]. The meeting was held to decide the eligible recipients based on criteria set by central government. These criteria are the area

of the building, type of building floor, type of wall, toilet facilities (MCK), sources of lighting, sources of drinking water, cooking fuel, purchase of new clothes, number of meals a day, medical ability, work, income, last education, type of asset ownership [4].

In the results of committee meetings, it was often found irregularities resulted in jealousy among people who did not receive Raskin assistance [5]. Theproblems are due to the assessment of the criteria set out above is still inaccurate and not objective. Thus, there is an impression of partiality towards certain beneficiaries by the committee.

This problem will be solvedby utilizing a decision support system (DSS). There are several DSS that have been developed to support the Raskin program. Ilyas and Kusmiati have applied the AHP (Analytic Hierarchy Process) method to determine the Raskin recipients [6, 7]. In the process, Ilyas used the expert choice 11 application, while Kusmiati builds a special application for SDS to determine the Raskin recipients. Both of these studies provide a result that can be used to assist decision making, but the absence of a comparison with the primary data make the result of the system still unable to solve the problem above. Unlike Ilyas and Kusmiati, Eni [8] used the Weight Product method to determine the eligibility of Raskin recipients. Dewi [9] applies the Simple Additive Weight (SAW) method to build a decision support system for the amount of poor rice that will be received by each recipient. Both Eni and Dewi also have not compared the result of the system to the primary data for validation.

Therefore, in this study, the PROMETHEE method was applied for those included with the comparison method of primary data as the validation of a decision support system for the acceptance of poor rice. PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) is a multi-criteria decision support method developed by Brans et al. [13].As a multi-criteria analysis method, PROMETHEE is easier to use and apply than other methods. The results of the comparison indicate that PROMETHEE has some strength compared with AHP (analytic hierarchy process) in the multi-criteria analysis [14].

PROMETHEE utilization in various studies has increased since this method was officially introduced by Brans [13]. Behzadian et al. conducted a literature review of 195 papers related to PROMETHEE and managed to categorize them into nine areas: Environment Management, Hydrology and Water Management, Business and Financial Management, Chemistry, Logistic and Transportation, Manufacturing and Assembly, Energy Management, Social and other areas such as Medicine, Agriculture, Education, Design, Government, and Sport [12]. In the area of Business and Financial Management, Albadvi et al. used PROMETHEE to develop a decision support model for selecting a superior stock in a stock exchange [15]. Meanwhile, in the education area, Jati et al. developed a new approach in ranking webometrics of universities in Indonesia by utilizing Entropy as a criteria weighting method and PROMETHEE II as ranking [16].

In the Manufacturing area, Vinodh et al. used PROMETHEE as a method for selecting the sustainability concept of manufacturing organizations using social, economic, and high-angle criteria for natural resources [17]. On the social topic, Johnson et al. used PROMETHEE for vouchers for the selection of housing environments that were by people's preferences [18]. Meanwhile, the object of this study is on a social topic, but PROMETHEE has never been used to solve the selection problem of Raskin beneficiaries.

2. Research Method

2.1. PROMETHEE Method

PROMETHEE is a method of determining priority in a multi-criterion and commonly referred to as the MCDA (Multi-Criteria Decision Aid) [10]. This research using PROMETHEE I and

PROMETHEE II to provide a complete ranking of a possible alternative. There are several steps used in this research to determine the most appropriate beneficiaries *Raskin* program.

Firstly, determine all the alternative and criterion, subsequently, compare it in pair-wise. After that, each criterion is evaluated to determine whether it must be maximized or minimized. There is two information that needs to be considered when using PROMETHEE, namely weight, and type of preference function.

2.1.1. Type of Preference Function

The PROMETHEE has six types of preference function [11], the first is (1) usual type, (2) U-shape or quasi-type, (3) V-shape or linear type, (4) level type, (5) linear quasi-type, and (6) Gaussian type. This research only used one type of preference functions, that is the usual type. Figure 2illustrates the step-wise of PROMETHEE method, to determine the most appropriate beneficiaries of *Raskin* program.

Step 1. Determination of deviations based on pair-wise comparisons

$$d_j(a,b) = g_j(a) - g_j(b \quad (1)$$

Where $d_j(a,b)$ denotes the difference between the evaluations of a and b on each criterion

Step 2. Application of the preference function

$$P_j(a,b) = F_j[d_j(a,b)] \quad j=1,\ldots..,k \quad (2)$$

Where $P_j(a,b)$ denotes the preference of alternative a with regard to alternative b on each criterion, as a function of $d_j(a,b)$.

Step 3. Calculation of an overall or global preference index

$$\forall a,b \in A, \pi(\mathrm{a,b}) = \sum_{j=1}^{k} Pj(a,b), wj \quad (3)$$

Where $\pi(\mathrm{a,b})$ of a over b (from 0 to 1) is defined as the weighted sum $p(a,b)$ of for each criterion, and w_j is the weight associated with jth criterion.

Step 4. Calculation of outranking flows/The PROMETHEE I partial ranking

$$\emptyset^{+}(a) = \frac{1}{n-1}\sum_{x\in A}\pi(a,x) \quad (4) \quad \text{and} \quad \emptyset^{-}(a) = \frac{1}{n-1}\sum_{x\in A}\pi(a,x) \quad (5)$$

Where $\emptyset^{+}(a)$ and $\emptyset^{-}(a)$ denote the positive outranking flow and negative outranking flow for each alternative, respectively

Step 5. Calculation of net outranking flows/The PROMETHEE II complete ranking

$$\emptyset(a) = \emptyset^{+}(a) - \emptyset^{-}(a) \quad (6)$$

Where $\emptyset(a)$ denote the net outranking flow for each alternative

Figure 1. Stepwise Procedure For Implemented PROMETHEE [12].There are five main steps on PROMETHEE calculation. On the fourth step called PROMETHEE I, calculated leaving flow and entering flow from each alternative. Meanwhile on the fifth step obtained net flow value, which is the difference between leaving flow value and entering flow value.

2.2. Validation Method

The validation process is carried out to ensure the accuracy of the result obtained from the PROMETHEE method, Validation method that used in this research is to compare the original data of the 2017 beneficiary list of *Raskin* program with PROMETHEE calculation.

3. Results and Analysis

Data used in this research is the recipients of subsidized rice data in Cilinaya region, Mataram city, West Nusa Tenggara, Indonesia. The data consists of 40 households in total. There are 15 criterions used as the assessments and weight criteria as shown in Table 1. Furthermore, PROMETHEE

processes each criterion using the usual preference type. The result then validated by comparing it with the real recipients of subsidized rice data.

Table 1. Criterion, each criterion has four sub-criterion which the range of its weight value is 1 – 4.

No.	Criterion
1	Building area
2	Type of house floor
3	Type of house wall
4	Type of toilet house
5	Type of Lighting Source
6	Type of Water Source
7	Type of Job's
8	Type of asset ownership
9	Type of Cooking fuel
10	The frequency of consuming meat, milk, and chicken
11	The frequency of meals in a day
12	Insurance ownership
13	Last Education
14	Income
15	The frequency of buying new clothes

Table 1 shows that there is 15 criteria used in this research. Those criteria are the criteria used by the government to determine the recipients of subsidized rice. Each criterion has foursub-criterion where its minimum-maximum weight value is represented by 1 – 4.

3.1.Pair-Wise Comparisons

After conducting data, the process is continued to the evaluation using the PROMETHEE algorithm. In the first stage, the comparison between each alternative and criteria.

Table 2. Pair-Wise Comparisons, compare each criterion and sub-criterion with each beneficiary, which consists of 40 beneficiaries. This table only shows the first two beneficiary and last beneficiary.

No	Criterion	Alternative 1	Alternative 2	Alternative 40
1	Building area	4	4	4
2	Type of house floor	2	2	2
3	Type of house wall	3	1	1
4	Type of toilet house	3	1	1
5	Type of Lighting Source	2	1	1
6	Type of Water Source	1	1	1
7	Type of Job's	4	4	4
8	Type of asset ownership	3	3	4
9	Type of Cooking fuel	2	2	3
10	The frequency of consuming meat, milk, and chicken	3	3	2
11	The frequency of meals in a day	2	2	2
12	Insurance ownership	3	3	2
13	Last Education	2	3	3
14	Income	2	2	3
15	The frequency of buying new clothes	3	2	4

The pair-wise comparisons matrix of alternative and criterion obtained from the first stage, as shown in Table 2, then either its value determined to be maximized or minimized at the second stage.

In this research determined that all of the criterion value is maximized. It means the criteria with the highest weight value are preferred.

3.2. Application of the preference function

The PROMETHEE has six types of preference function. The only the usual type of preference function implemented in this research. Its implementation is based on the compatibility of data used and considers how the decision maker make the decision

3.3. Calculation of an overall or global preference index

Each alternative is compared to calculate the preference value and preference index .The preference value is defined with numbers 0 and 1, which are calculated using Equation (1).

$$\begin{cases} \pi(a,b) = \sum_{j=1}^{k}(a,b)w_j \\ \pi(a,b) = \sum_{j=1}^{k}(b,a)w_j \end{cases} \quad (1)$$

The preference value is 0 if $d \leq 0$, and 1 if $d > 0$, where d is the difference function between the alternatives ($\{d = f(a) - f(b)\}$). The preference index is then determined from the average weight value of preference function. It is obtained using equation (2).

$$\emptyset_{(a,b)} = \sum_{i=1}^{n} \pi Pi(a,b) : \forall a,b = \in A \quad (2)$$

$\emptyset_{(a,b)}$ is the preference intensity of a decision maker stating that alternative a is better than alternative b with simultaneous consideration of all criteria. The preference index value is expressed as 0 and 1, if $\emptyset_{(a,b)} = 0$ indicates a weak preference for alternatives $a > b$ based on all criteria. If $\emptyset_{(a,b)} = 1$ means showing strong preference for alternatives $a > b$.

3.4. Calculation of outranking flows/The PROMETHEE I partial ranking

At this stage the calculation of outranking flows or PROMETHEE I is carried out which will state the positive outranking flow and negative outranking flow values. The two outranking flows are commonly referred to as Leaving Flow and Entering Flow.

3.4.1.Calculation of positive outranking flow or leaving flow

Positive outranking flow or leaving flow is the number of curved line values that have direction away from the node a. To determine each node on the graph of the positive outranking flow or leaving flow using the following equation 3a:

$$\emptyset^{+}(a) = \frac{1}{n-1}\sum_{x \in A} \pi(a,x) \quad (3a)$$

Where π (a, x) shows that alternative preference is better than x, which is all other alternatives. At this stage, the leaving flow value is obtained from all alternatives used in this study.

3.4.2.Calculation of negative outranking flow or entering flow

In contrast to leaving flow, negative outranking flow or entering flow finds out what is the number of curved lines that have an approaching direction with vertices a. The following equation is used to obtain the entering flow value of each alternative 3b:

$$\emptyset^{-}(a) = \frac{1}{n-1}\sum_{x \in A} \pi(a,x) \quad (3b)$$

After calculating the two outranking flows above, all alternatives, 40 subsidized rice recipients, already have the value of leaving flow and entering flow.

3.5. Calculation of net outranking flows or PROMETHEE II complete ranking

In PROMETHEE II calculations are made by utilizing the leaving flow and entering flow values that are owned by each perspective of subsidized rice recipient. The calculation uses the following equation 4 :

$$\emptyset(a) = \emptyset^{+}(a) - \emptyset^{-}(a) \quad (4)$$

If the calculation results show a value of ∅ (a) positive, then the alternative is deemed eligible as the recipient of subsidized rice (accepted). But if the value of ∅ (a) is negative, then the alternative is declared ineligible as the recipient of subsidized rice (rejected). The results of these calculations are shown in a table diagram like Figure 3 below.

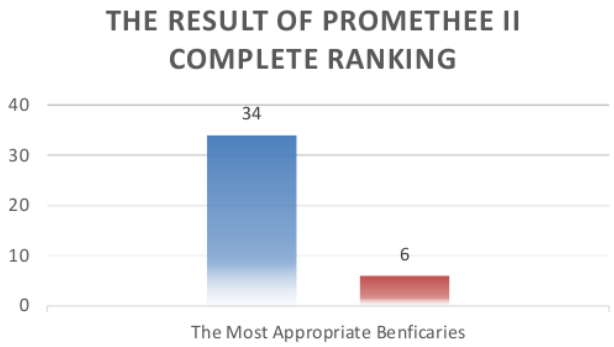

Figure 2. The Result of PROMETHEE II Complete Ranking shows that there are 34 eligible as the recipient of subsidized rice, while the other sixwere rejected.

Based on the calculation using Promethee, out of 40 prospective, only 34 candidates were declared eligible as the recipient of subsidized rice while six other candidates were rejected

3.6. Validating the result using real data

Validation aims to compare PROMETHEE results with a list of Raskin beneficiaries generated from board meetings. Forty recipients were declared eligible by the results of the meeting. Meanwhile, from the calculation using PROMETHEE, only thirty-four prospective recipients were declared eligible as the receiver, while the other six were rejected. The percentage of accuracy is determined using the following equation:

$$\text{Accuracy} = \frac{Accepted}{All\ Data}\ X\ 100\ \% \quad (5)$$

From the calculation, it's concluded that the accuracy of this system is reached 85%.

4. Conclusion

The PROMETHEE has an accuracy value of 85% after validation testing. This accuracy is obtained from the comparison of the results of PROMETHEE calculations with 2017 beneficiary list. Testing was conducted on 40 beneficiaries, and it was found that only six beneficiaries were not in line with the 2017 beneficiary list. This indicates that PROMETHEE can be used as a stakeholder decision support system.

In this study only use one type of preference function, namely usual type. Meanwhile,there are five other types of preferences that ware not used in this study. This means there is a gap for further research. They can take advantage of that loophole to get a better level of accuracy. Other than that, future researchers can use other methods that are more suitable with the object of research to get more optimal results.

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