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The Application of Weighted Ranking Method Using Combination of ROC and CPI to Select Eligible Family for *Keluarga Harapan Program* Aids

Aishiyah Saputri Laswi [a,1,*]; Ulvah [b,2]; Dasril [b,3]
[a] *Palopo State Islamic Institute, Jl. Agatis, Palopo City 91914, South Sulawesi, Indonesia*
[b] *University Cokroaminoto Palopo, Jl. Lamatacelling No. 19 Palopo City 91911, South Sulawesi, Indonesia*
[1] *aishiyahsaputrilaswi@iainpalopo.ac.id ;* [2] *ulvahinformatik@gmail.com*
* *Corresponding author*

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Abstract

The *Keluarga Harapan Program* (KHP), a financial assistance, is a program launched by the government to deal with poverty in various regions of Indonesia by conducting direct surveys and collecting data on disadvantaged families in each region. However, the issue is that many recipients do not meet the appropriate criteria or are not categorized as recipients. The Composite Performance Index and Rank Centeroid algorithms are a solution in the selection process for the recipients for the KHP by carrying out the analysis and comparison stages of whether they are categorized as KM (Disadvantage Families) through several stages. The results obtained based on analysis for recipient selection with a minimum performance index coverage value of 70% can be categorized as eligible to receiv assistance. In this study, 50 KM data samples were taken with the highest assessment value 128.41. In the top tenth ranking of the highest score from the 50 data held indicated that they were truly entitled to receive PKH KM financial assistance. Before using this method, only around 40% was eligible recipients.

Keywords: Algorithm; Composite Performance Index; Rank Order Centroid; Selection Recipients.

Introduction

Keluarga Harapan Program (PKH) is a conditional social program assistance on the Poor Family (KM) determined as a recipient of PKH benefits [1]. As an acceleration attempt to countermeasures poverty, since 2007 the Indonesian Government has implemented PKH [2], [3]. *Program Perlindungan Sosial* (Social Protection Program) is also known internationally as Conditional Cash Transfer (CCT) [4]. As a conditional social assistance program, PKH opens access for poor family especially pregnant women and children to utilize various health service facilities (*faskes*) and educational service facilities (*fasdik*) available nearby. The benefits of PKH are also starting to be encouraged for disabled people and elderly by maintaining level well-being social services are in accordance with the mandate of the constitution and *Nawacita* President of the Republic of Indonesia.

Through PKH KM, it is encouraged to have access and utilize health, education, food and nutrition, care and assistance services, including access to various ongoing complementary protection of social programs [5]. PKH aimed at becoming epicenter and center of excellence for poverty countermeasures. The program was also aimed to synergize various social protections and empowerment programs by considering several conditions for the recipients categorized as poor family [6]. Frequent problems occur during the recipient selection of the social protection program including PKH is often given not to the right person. In many cases this can leads to jealousy among society, those who do not receive it often claim that they are supposed to be in the list [7], [8]. This happened because an objective ranking was not made in a priority list ranking.

Some actual computing system methods can be used to overcome the ranking list. These computing systems include: method ranking with various technique types like ranking weighted, subset partitioning and other ranking techniques [9]–[13]. Another method is a selection system with a supporting decision algorithm such as TOPSYS

and AHP [11]. Clustering methods can also be used to separate between the right people [14]. By implementing these methods, then priority ranking of the recipients can be done correctly.

This research aimed to perform selection for the recipient PKH social assistance by utilizing computing system. The employed method was the weighted ranking by sorting recipients starting from the most deserving to the family that should not. This technique was used to select recipient of PKH social assistance services in accordance with the criteria and requirements so it does not cause jealousy to the society [15].

Method

In this research, the method used was weighted ranking for the selection of financial assistance. This ranking was combined with two other methods, the first method was to use the Rank Order Centroid (ROC) which is used to determine order criteria along with its weight [16] – [19]. The obtained weighting criteria was then used in the Composite Performance Index (CPI) method for the ranking process. The Composite Performance Index method is a type of method used to determine the range in the retrieval process of deciding the best decision based on identification of positive and negative trends [5], [20], [21]. The higher selection final values, the better the decision taken and vice versa the lower negative values, the better it is for the picking trend decision. The Composite Performance Index method has been applied to many research as a decision support system [22], [23]. **Figure 1** shows the combining system of ROC and CPI.

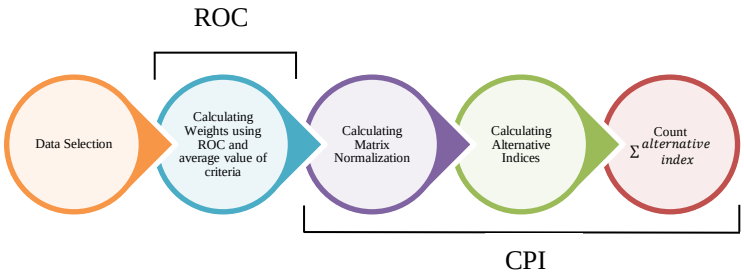

Figure 1. Ranking System with Integration ROC and CPI methods

Rank Order Centroid

Rank Order Centroid (ROC) is a simple algorithm to determine the level of importance or priority of criteria. The ROC method produces weights for each criterion in order to prioritize given criteria. The criteria were made according to a statement "Criterion 1 is more important than criterion 2, which is more important than criterion 3" and so forth up to the n-th criterion. The determination priority rules was the the highest value was the most important value compared to other values so that [24], [25],

If criteria (K)

$$K_{r1} \geq K_{r2} \geq K_{r3} \geq \cdots \geq K_m \quad (1)$$

Then the weight (W),

$$W_1 \geq W_2 \geq W_3 \geq \cdots \geq K_n \quad (2)$$

Furthermore, if k is the number of criteria, then

$$W_1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\ldots+\frac{1}{k}}{k} \quad (3)$$

$$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\ldots+\frac{1}{k}}{k} \quad (4)$$

$$W_3 = \frac{0+0+\frac{1}{3}+\ldots+\frac{1}{k}}{k} \quad (5)$$

$$W_k = \frac{0+\cdots+0+\frac{1}{k}}{k} \quad (6)$$

ROC weighting in general can be stated as Equation 7.

$$W_k = \frac{1}{k} \sum_{i=1}^{k} \left(\frac{1}{i}\right) \quad (7)$$

Composite Performance Index

Composite Performance Index (CPI) is an composite index to determine the evaluation as well as the ranking from many alternatives based on many criteria [26] . The solution procedure of the CPI method is:

- *Normalization Matrix*

The next step is to determine the formula of the social assistance recipient criteria by using Centroid Rank Order, then it is proceed with selecting recipient data based on criteria using the Composite Performance Index method using a formula Matrix Normalization (A_{ij}) and Alternative Index (I_{ij}) [22], [23].

$$A_{ij} = \frac{x_{i,j}}{X_{ij}(min)} \times 100 \quad (8)$$

- *Finding for alternative indexes*

After determining matrix value to determine weight criteria based on existing data. Furthermore, counting alternative values (I_{ij}) where this value is used to determine data based on the survey results.

$$I_{ij} = A_{ij} \times P_j \quad (9)$$

After obtaining the index results, the next alternative is to calculate all alternative index values (K_rN) of each criterion with the following Equation 10.

$$K_rN_1 + K_rN_2 + K_rN_3 + \cdots + K_rN_n \quad (10)$$

Final stage is sorting the K_rN values from the biggest value to the smallest one to obtain desired data ranking.

Results and Discussion

The selection process of the financial assistance program called PKH was implemented according to the stages in the proposed method. The stage began from selection of data used to rank recipients of the PKH. After that, the ROC stages followed by CPI stages. The stages were ended with the ranking process of qualified for the social assistance.

ROC Stages

The following ROC stages are to determine criteria of the financial assistance recipients. Conditional criteria would be selected by weighting the most important criteria using this ROC method. The results of criteria determination can be seen in **Table 1**.

Table 1. Criteria

Criteria	Information
K1	Electricity bills
K2	property tax
K3	Income
K4	Family Economic Conditions

Table 1 is initial table to be used to weight candidates by entering criteria based on the recipient condition of PKH social funds [27], [28]. Furthermore after fulfilling criteria in the **Table 1**, the calculations below are carried out to weight each criterion [29], [30]:

K1 = (1+1/2+1/3+1/4)/4 = 0.521
K2 = (0+1/2+1/3+1/4)/4 =0.271
K3 = (0+0+1/3+1/4)/4 = 0.146
K4 = (0+0+0+1/4)/4 = 0.063

The weighting results above are based on value criteria obtained using the ROC method, where the data were entered into the Table 2.

Table 2. Weight

Criteria	Information
K1	0.521
K2	0.271
K3	0.146
K4	0.063

IHK Stages

The results obtained from Table 2 is based on designed criteria assessment. The above weight value would be then reused in the CPI algorithm which affects 50 people who receive the social funds of PKH. The data was obtained from data collection in the mid-2022. After that, it would be implemented in Table 3.

Table 3. Recipient

No	Criteria	K1	K2	K3	K4	No	Criteria	K1	K2	K3	K4
1	P1	90	90	75	70	26	P26	80	90	80	80
2	P2	80	90	80	75	27	P27	90	90	80	75
3	P3	80	80	80	70	28	P28	90	87	92	95
4	P4	80	90	80	70	29	P29	90	85	90	90
5	P5	75	90	80	70	30	P30	90	90	80	75
6	P6	90	90	80	70	31	P31	90	90	80	90
7	P7	75	70	80	75	32	P32	90	70	80	80
8	P8	90	90	80	75	33	P33	90	90	80	75
9	P9	90	92	80	75	34	P34	80	75	80	75
10	P10	80	80	80	75	35	P35	75	90	80	80
11	P11	70	75	80	80	36	P36	85	80	90	82
12	P12	75	90	80	75	37	P37	75	80	80	75
13	P13	80	75	90	75	38	P38	80	75	80	75
14	P14	75	78	90	75	39	P39	70	70	70	70
15	P15	75	80	80	70	40	P40	80	80	80	90
16	P16	75	80	80	80	41	P41	80	90	80	75
17	P17	90	90	80	90	42	P42	80	70	75	80
18	P18	80	85	90	80	43	P43	70	70	70	70
19	P19	75	80	80	75	44	P44	90	70	70	80
20	P20	80	80	75	75	45	P45	80	75	80	75
21	P21	80	90	80	80	46	P46	80	75	80	70
22	P22	90	90	80	90	47	P47	80	75	80	75
23	P23	80	90	80	75	48	P48	75	75	80	75
24	P24	75	80	80	70	49	P49	75	70	70	70
25	P25	75	82	80	75	50	P50	80	90	80	85

From Table 3, it is obtained the minimum value percentage of the calculation table based on the determined criteria with the minimum percentage limitation value as shown in Table 4.

Table 4. Minimum Percentage

Criteria	Information
K1	70
K2	70
K3	70
K4	70

After obtaining limitation minimum value in Table 4 above then step furthermore that is calculate data based on data collection. The first step is to determine values matrix normalization using Equation 8 in the CPI algorithm method with the results in Table 5.

Table 5. Normalization Results Matrix

No	Criteria	K1	K2	K3	K4	No	Criteria	K1	K2	K3	K4
1	P1	128.57	128.57	107.14	100.00	26	P26	114.29	128.57	114.29	114.29
2	P2	114.29	128.57	114.29	107.14	27	P27	128.57	128.57	114.29	107.14
3	P3	114.29	114.29	114.29	100.00	28	P28	128.57	124.29	131.43	135.71
4	P4	114.29	128.57	114.29	100.00	29	P29	128.57	121.43	128.57	128.57

No	Criteria	K1	K2	K3	K4	No	Criteria	K1	K2	K3	K4
5	P5	107.14	128.57	114.29	100.00	30	P30	128.57	128.57	114.29	107.14
6	P6	128.57	128.57	114.29	100.00	31	P31	128.57	128.57	114.29	128.57
7	P7	107.14	100.00	114.29	107.14	32	P32	128.57	100.00	114.29	114.29
8	P8	128.57	128.57	114.29	107.14	33	P33	128.57	128.57	114.29	107.14
9	P9	128.57	131.43	114.29	107.14	34	P34	114.29	107.14	114.29	107.14
10	P10	114.29	114.29	114.29	107.14	35	P35	107.14	128.57	114.29	114.29
11	P11	100.00	107.14	114.29	114.29	36	P36	121.43	114.29	128.57	117.14
12	P12	107.14	128.57	114.29	107.14	37	P37	107.14	114.29	114.29	107.14
13	P13	114.29	107.14	128.57	107.14	38	P38	114.29	107.14	114.29	107.14
14	P14	107.14	111.43	128.57	107.14	39	P39	100.00	100.00	100.00	100.00
15	P15	107.14	114.29	114.29	100.00	40	P40	114.29	114.29	114.29	128.57
16	P16	107.14	114.29	114.29	114.29	41	P41	114.29	128.57	114.29	107.14
17	P17	128.57	128.57	114.29	128.57	42	P42	114.29	100.00	107.14	114.29
18	P18	114.29	121.43	128.57	114.29	43	P43	100.00	100.00	100.00	100.00
19	P19	107.14	114.29	114.29	107.14	44	P44	128.57	100.00	100.00	114.29
20	P20	114.29	114.29	107.14	107.14	45	P45	114.29	107.14	114.29	107.14
21	P21	114.29	128.57	114.29	114.29	46	P46	114.29	107.14	114.29	100.00
22	P22	128.57	128.57	114.29	128.57	47	P47	114.29	107.14	114.29	107.14
23	P23	114.29	128.57	114.29	107.14	48	P48	107.14	107.14	114.29	107.14
24	P24	107.14	114.29	114.29	100.00	49	P49	107.14	100.00	100.00	100.00
25	P25	107.14	117.14	114.29	107.14	50	P50	114.29	128.57	114.29	121.43

After obtaining the calculation of normalization matrix above, then a weight multiplication process of each criterion would be carried out for recipients by multiplying the normalization results matrix using Equation 9. The results are in **Table 6**.

Table 6. Index Values Alternative

No	Criteria	K1	K2	K3	K4	No	Criteria	K1	K2	K3	K4
1	P1	66.99	34.84	15.64	6.30	26	P26	59.54	34.84	16.69	7.20
2	P2	59.54	34.84	16.69	6.75	27	P27	66.99	34.84	16.69	6.75
3	P3	59.54	30.97	16.69	6.30	28	P28	66.99	33.68	19.19	8.55
4	P4	59.54	34.84	16.69	6.30	29	P29	66.99	32.91	18.77	8.10
5	P5	55.82	34.84	16.69	6.30	30	P30	66.99	34.84	16.69	6.75
6	P6	66.99	34.84	16.69	6.30	31	P31	66.99	34.84	16.69	8.10
7	P7	55.82	27.10	16.69	6.75	32	P32	66.99	27.10	16.69	7.20
8	P8	66.99	34.84	16.69	6.75	33	P33	66.99	34.84	16.69	6.75
9	P9	66.99	35.62	16.69	6.75	34	P34	59.54	29.04	16.69	6.75
10	P10	59.54	30.97	16.69	6.75	35	P35	55.82	34.84	16.69	7.20
11	P11	52.10	29.04	16.69	7.20	36	P36	63.26	30.97	18.77	7.38
12	P12	55.82	34.84	16.69	6.75	37	P37	55.82	30.97	16.69	6.75
13	P13	59.54	29.04	18.77	6.75	38	P38	59.54	29.04	16.69	6.75
14	P14	55.82	30.20	18.77	6.75	39	P39	52.10	27.10	14.60	6.30
15	P15	55.82	30.97	16.69	6.30	40	P40	59.54	30.97	16.69	8.10
16	P16	55.82	30.97	16.69	7.20	41	P41	59.54	34.84	16.69	6.75
17	P17	66.99	34.84	16.69	8.10	42	P42	59.54	27.10	15.64	7.20
18	P18	59.54	32.91	18.77	7.20	43	P43	52.10	27.10	14.60	6.30
19	P19	55.82	30.97	16.69	6.75	44	P44	66.99	27.10	14.60	7.20
20	P20	59.54	30.97	15.64	6.75	45	P45	59.54	29.04	16.69	6.75
21	P21	59.54	34.84	16.69	7.20	46	P46	59.54	29.04	16.69	6.30
22	P22	66.99	34.84	16.69	8.10	47	P47	59.54	29.04	16.69	6.75
23	P23	59.54	34.84	16.69	6.75	48	P48	55.82	29.04	16.69	6.75
24	P24	55.82	30.97	16.69	6.30	49	P49	55.82	27.10	14.60	6.30
25	P25	55.82	31.75	16.69	6.75	50	P50	59.54	34.84	16.69	7.65

After obtaining the normalization matrix results above, a weight multiplication process would be carried out to each criteria of the recipients by multiplying the normalization results matrix according to Equation 10. The results are in **Table 7**.

Table 7. Eligibility Ranking of PKH Recipients

Criteria	Results	Rating	Criteria	Results	Rating
P28	128.41	1	P12	114.10	26
P29	126.77	2	P13	114.10	27

Criteria	Results	Rating	Criteria	Results	Rating
P17	126.62	3	P10	113.95	28
P22	126.62	4	P5	113.65	29
P31	126.62	5	P3	113.50	30
P9	126.05	6	P20	112.90	31
P8	125.27	7	P34	112.02	32
P27	125.27	8	P38	112.02	33
P30	125.27	9	P45	112.02	34
P33	125.27	10	P47	112.02	35
P6	124.82	11	P46	111.57	36
P1	123.77	12	P14	111.54	37
P36	120.38	13	P25	111.01	38
P50	118.72	14	P16	110.68	39
P18	118.42	15	P19	110.23	40
P21	118.27	16	P37	110.23	41
P26	118.27	17	P15	109.78	42
P32	117.98	18	P24	109.78	43
P2	117.82	19	P42	109.48	44
P23	117.82	20	P48	108.30	45
P41	117.82	21	P7	106.36	46
P4	117.37	22	P11	105.03	47
P44	115.89	23	P49	103.82	48
P40	115.30	24	P39	100.10	49
P35	114.55	25	P43	100.10	50

Based on the results using the calculation method of Rank Order Centroid and Composite Performance Index algorithms. Based on analysis results value, it is obtained that the character value was in first place with a highest score, 128.41.

Conclusion

In conclusion, the conducted research is about to determine who should and should not receive the PKH aids for the poor family. Determination of PKH uses several assessment criteria, namely electricity bill, property text, income, and economic condition of the families with a sample of 50 houses considered as poor family in a subdistrict. The analysis results using the method of Centroid Rank Order Algorithm to determine assessment criteria and The Composite Performance Index algorithm is used to seek highest values based on the top ranking.

The highest-ranking score is 128.41 and the lowest is 100.10. Based on order that the top 10 recipients are P28, P29, P17, P22, P31, P9, P8, P27, P30 and P33. Before using the calculation of Rank Order Centroid and Composite Performance Index Algorithm, the recipients are P9, P27, P8, P43, P50, P39, P49, P17, P42 and P29. If it is compared, before and after using this method, the eligible ones were P9, P27, P8 and P17. It is only about 40% of recipients are eligible.

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