NASKAH 1

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Importance-weighted Ranking Methods for Preference the Covid-19 Pandemic Social Assistance

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Abstract*: Issues importance-weighted value is a critical aspect of decision making. Differences in weight, even the slightest change in weight assignment, can drastically change the final decision. Moreover, in the case of distributing social assistance during the Covid-19 pandemic, objectivity and accuracy of weighting the criteria for potential recipients are very important applied for the welfare of the community. The proposes study 3 popular models of ranking methods for weighting criteria in the internet data package assistance cases. Weighting is given to 390 alternatives with 5 decision-making criteria based on online learning needs and economic cost capabilities. The decision analysis method uses the reference point and optimization from Moora. The study results were found accuracy, precision and error rate performance each method using a confusion matrix approach. The study results discussed raised several important points of findings, that the three ranking methods (RS, RR, ROD) have their respective characteristics in weighting importance, where the level of accuracy and precision of the rank-sum method is better than the RR and ROD methods (for the case: 5 criteria; 390 alternatives). Other things in giving weight value from important to most important are comparable, and the weight value of the non-benefit (cost) criteria in the ranking method have a significant effect on performance results. These three methods are simple in use and with the assessment of replacement weights that can be determined how important these variables are to the principal of these criteria.

***Keywords* : Weighting, Rank method, criterion, decision.**

I. INTRODUCTION

The determination of criterion weights is a problem that often arises in many MCDM methods[1], [2]. Various quantitative and qualitative weighting methods have been discussed and reviewed to assist in multi-criteria decision problems in the form of single or group decision making[2]. Importance-weighted methods in multi-criteria decision analysis require a lot of too much precision and are cognitively demanding, and too much time and effort[3]. In practice, it is difficult for even one decision-maker to assign numerical relative weights to different decision criteria[2].

Several studies and critical analyzes of weighting criteria such as that of E. Triantaphyllou and A. Sánchez[4], which discusses A sensitivity analysis approach for some deterministic MCDM methods, prescriptive criteria weight elicitation in[5], comparison of weighting methods[6], integrated MCDM for a destitute problem[7] and other.

Different weighting methods or even small changes in weight determination can change the final decision. Thus, the weighting is a critical aspect of multi-criteria decision making[8].

A decision in determination appropriate weighting method is an important effort and choice in solving multi-criteria decision problems. Many researchers dismiss the difficulty of measuring and interpreting criterion weights and assume that the importance of criteria is well understood by all decision-makers[9].

The main objective of this research is to implement different importance-weighting in the five ranking methods for the management of the Covid-19 pandemic social assistance. Various forms and types of assistance program are currently being distributed by the Regional Government and institutions in Indonesia as an effort to reduce the impact of the Covid-19 pandemic. For this reason, we provide an example of a case in the internet data assistance to teachers-students as support from educational institutions for online learning - work from home (L-WFH).

In this study, a questionnaire was designed and given to 390 undergraduate students of the Informatics department, Mulawarman University. This survey aims to collect information concerned to the internet data needed for online learning and capability economy, and including, the rank decision criteria according to importance (most important to least important)[10]. From this questionnaire, 5 (five) references were determined as the criteria for providing internet data package assistance along with the importance's level, i.e; the amount of data package usage, the number of online learning courses, the number of credit courses, the monthly cost, the purchasing power of internet data packages, the eating costs, the transportation costs, and other costs.

Weighting methods are classified in a variety of different ways, found in[9], i.e: holistic or unravelled, direct or indirect, statistical or algebraic, and compensatory or non-compensatory. Further, according to [9] several popular weighting methods such as the ranking method include scoring, point allocation, pairwise comparison[11], outranking method, trade-off analysis and others, each of which is different in terms of complexity, accuracy, convenience for users, and theoretical foundation, as well as generating a different set of criterion weights[9].

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In general, the determination of the weight of social assistance from educational institutions in Indonesia is determined by elicitation, the assumption that elicitation is made relative to the distribution of weights assigned-held by the decision-maker (institution manager), skipping the criteria elicitation and assigning the same weight to each criterion[3]. However, the loss of information then becomes enormous and is most often useful for at least ranking criteria[3].

Because ratings are (often) easier to assign than correct numbers. The ranking of the criteria can then be handled by what are called replacement weights, which are derived from the appropriate rank. In addition, this technique has been widely used in solving scale, cardinal or ordinal data cases. For this reason, the approach to importance-weighted in this study uses the ranking method, which applies are; Rank Sum (RS), Rank Reciprocal(RR), and Rank Order Centroid or ROC. At the end of the discussion, we testing of the ranking methods performance using a confusion matrix for the model's accuracy, precision and error rate.

Contribution: the applied of the importance-weighted method in the case of social assistance decision making during the Covid-19 pandemic is very important to use for the effectiveness of the distribution of social assistance that is objective and on target according to the needs of potential beneficiaries. These research studies are that we propose various policymakers. In particular for the government and educational institutions or other institutions in Indonesia that promote various social assistance for the community's welfare.

II. MATERIAL AND METHODS

A. Design Analysis

An overview of the design analysis for importance-weighted process of the ranking method internet data assistance shown in "Figure I".

An overview in "Figure 1" the initial process of research starting from field observation activities. Observation of data collection through direct measurement of the use of internet data and questionnaires to 390 undergraduate students of the Department of Informatics, Mulawarman University during online learning. Both of these activities aim to obtain initial information for data analysis needs.

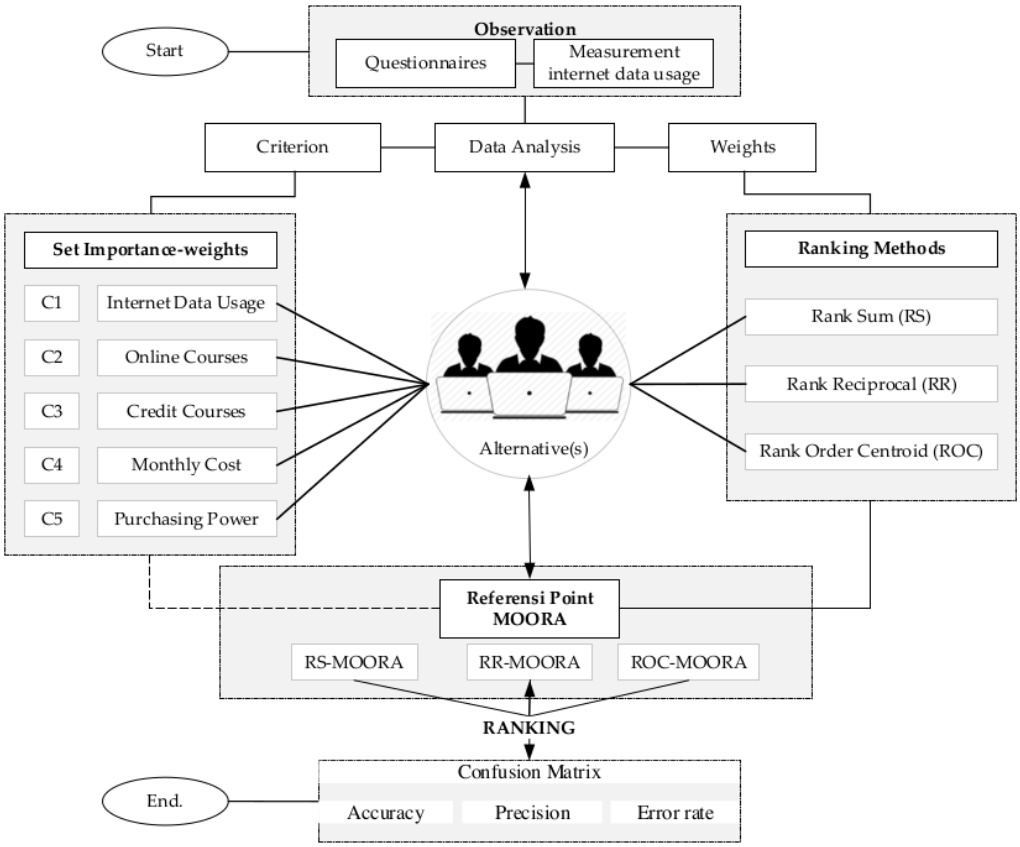

Fig. 1. Design analysis decision-making process

B. Importance-weights Set for Criterion

The criteria for internet data assistance were obtained from observations based on internet data needs in online learning and

students' economic cost abilities, including determining the importance-weights of the criteria., i.e: internet data usage (C1), online courses (C2), credit courses(C3), monthly cost(C4). and purchasing power (C5). Criteria data, ratings and importance-weights are shown in "Table I"

Table- I: Criteria and rating data

C	Ratings	Importance-weights		Max-min
C1	407 – 535 535 – 662 662 – 788 788 – 915 915 - 1042	Very-low Low Medium High Very-high	1	Max
C2	5; 6; 7; 8; 9		2	Max
C3	14 - 16 16 - 18 18 - 20 20 - 22 22 - 24	Very-low Low Medium High Very-high	3	Max
C4	1,200,000 - 1,780,000 1,780,000 - 2,360,000 2,360,000 - 2,940,000 2,940,000 - 3,520,000 3,520,000 - 4,100,000	Very-low Low Medium High Very-high	4	Min
C5	100000 200000 300000 400000 500000	Very-low Low Medium High Very-high	5	Min

C. Ranking Methods Set for Criterion

The importance-weighted analysis using the three ranking method which includes: Rank Sum method (RS), Rank Reciprocal (RR), and Rank Order Centroid (ROC). The calculation analysis and surrogate weights for each method are presented in "Figure II and "Table II"

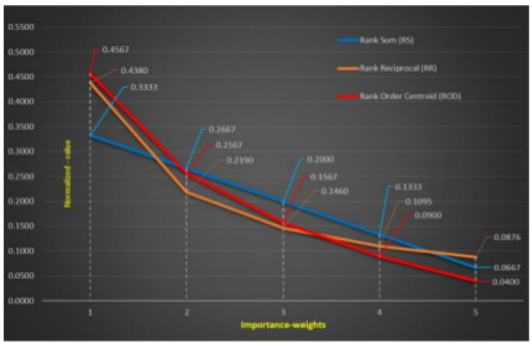

Fig. 2. The importance levels in rank weighting methods

Figure 2 explains that each Rank methods has high normalized values in each order of the most important weights and so that the three Rank methods have different importance levels in assessing weights.

Table- II: Rank methods

Rank methods	Importance weights		Equation	Eq.
RS	1 2 3 4 5	5 4 3 2 1	$w_i^{RS} = \frac{N+1-i}{\sum_{j=1}^{N}(N+1-j)}$	(1)
RR	1 2 3 4 5	1 0.5 0.33 0.25 0.2	$w_i^{RR} = \frac{1/i}{\sum_{j=1}^{N}\frac{1}{j}}$	(2)
ROC	1 2 3 4 5	0.457 0.257 0.157 0.090 0.040	$w_i^{ROC} = 1/N\sum_{j=i}^{N}\frac{1}{j}$	(3)

The three methods of rank presented in "Table II" are a simple approach for assigning weight to criteria. The criteria are ordered in order of importance to most important[1].

D. Reference Point MOORA

To evaluate the performance optimization of ranking methods (RS, RR, ROC), we use the reference point approach as a part of Moora[12],[13] which each response of an alternative on an objective is compared to a denominator, which is representative of all alternatives concerning that objective[14], [12].

$$x_{ij}^{*} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^{2}}}, \quad (4)$$

For optimization, these responses are added in case of maximization and subtracted in case of minimization[12]:

$$y_j^{*} = \sum_{i=1}^{i=g} x_{ij}^{*} - \sum_{i=g+1}^{i=n} x_{ij}^{*}, \quad (5)$$

Where, i = 1, 2, ..., g as the objectives to be max; i = g + 1, g + 2, ..., n as the objectives to be minimized; y_j^* a dimensionless number representing the response of alternative j with respect to all objectives; y_j^* can be positive or negative depending on the totals of its max and min. An ordinal ranking of the y_{ij}^* shows the final preference[12].

E. Testing Techniques: Confusion Matrix

The test results for each ranks method (RS, RR, ROC) were calculated for their metric (True-False) using confusion matrix[15], [16]with the arrangement shown in "Table III".

Table- III: True-False testing for ranks methods

		Actual Values	
		Positive (1)	Negative (0)
Predicted values	Positive (1)	TP	FP
	Negative (0)	FN	TN

1) TP: True Positive: cases where students are predicted (Positive) to receive assistance.
2) True Negative (TN): a case where a student is predicted not (negative) to receive assistance and in fact (actual) the student (true) does not receive assistance.
3) False Positve (FP): a case where a student who was predicted to be positive

received assistance, in fact they did not receive it. The prediction is wrong (False)

4) False Negative (FN): a case where a student who is predicted not to receive assistance (Negative), but in fact (TRUE) receives social assistance.

The confusion matrix represents the prediction and actual conditions of the data for each ranking method. Based on the confusion matrix, will test the method; accuracy, precission, and error rate. The calculation for each test following equation in "Table IV":

Table- IV: Metrics performance test for ranking methods

Metric	Equation	Eq.
Accuracy	$\frac{(TP + TN)}{(TP+FP+FN+TN)}$	(6)
Precision	$\frac{(TP)}{(TP+FP)}$	(7)
Error rate	$\frac{(FP + FN)}{(TP+FP+FN+TN)}$	(8)

III. RESULT AND DISCUSSION

One of the Indonesian Government's efforts to reduce the impact of the Covid-19 pandemic crisis through social assistance in the form of distributing internet data packages for students to access online learning during the implementation of government policies regarding large-scale social restrictions to stay work and learning from home[17]. This social assistance took a sample in one of the Informatics department's undergraduate programs, Universitas Mulawarman which involved 390 students as an alternative in the decision-making process. The data statistics for internet data package assistance are shown in "Table V"

Table- V: Statistics Data Analysis

	Data Usage	Courses	Akademic Credit	Monthly Cost	Purchasing Power
N	390	390	390	390	390
Mean	643.52	7.03	19.58	2050128.2	236666.67
Median	625.99	7	20	1945000	200000
Mode	407.92	9.00	24.00	1770000	100,000
Std.Dev.	134.55	1.49	3.30	487217.31	108337.12
Min.	407.92	5	14	1200000	100000
Max.	1041.9	9	24	4100000	400000
Very-low	89.00	84	61	109	58
Low	146.00	78	51	103	228
Medium	94.00	66	101	104	68
High	46.00	67	73	74	29
Very-high	15	95	104	0	7

A. Result: Normalization of importance-weighting ranking methods

Objective weighting criteria to state the importance level of each criterion relative to other criteria. The criterion weighting procedure was applied to ranking methods (RS, RR, ROD) for the management of student internet data package assistance in online learning during the Covid-19 Pandemic. The results of the normalization of importance-weights as surrogate weight are shown in the "Figure 3".

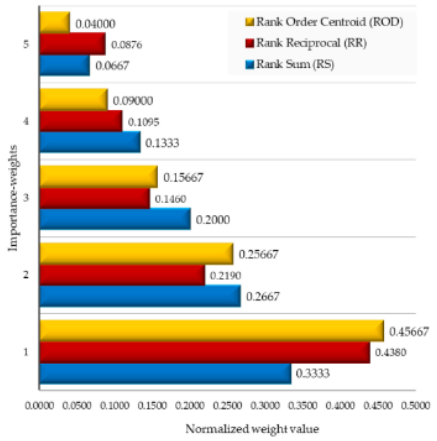

Fig. 3. The normalization of importance-weights

Figure 3 shows the results of normalization and importance-weights in the five rank methods for the 390 alternative, where the criterion that has the highest weighting value of normalization results is the ROD method for the 1st order most important weighted, then the 2nd order of importance is the RR method, and the 3rd order RS method. These normalize results then become the weighted importance value for calculation of reference point Moora.

B. Result: Reference point MOORA

The reference point approach as part of Moora is used to performance of the three ranking methods. In this section, we present the data from the calculation of the reference points using (6); Moora-RS, Moora-RR, and Moora-ROC.

1) Reference point calculation results: Moora-RS

Reference points results for each criterion weight (C) with N alternatif of 390 obtained importance-weight values (1-5) using the Rank Sum (RS) method shown in "Figure 4".

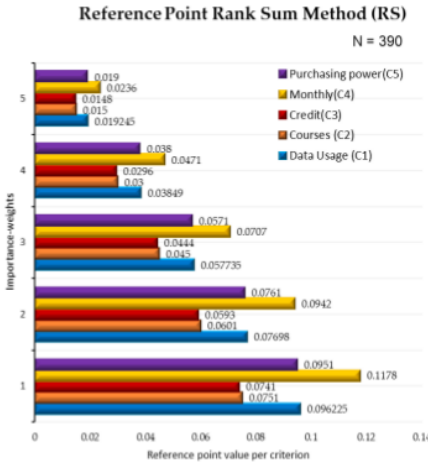

Fig. 4. Reference point for the rank-sum method

The result of the point per criterion reference becomes a reference for weight assessment of each alternative. Furthermore, the results of the weighted assessment per alternative are presented in "Table VI".

Table- VI: Reference point Moora-RS method

Alter-native	Data Usage (C1)	Courses	Credit courses	Monthly Cost	Purchasing Power
	max	*max*	*max*	*min*	*min*
A1	0.0192	0.0751	0.0741	0.0471	0.0190
A2	0.0385	0.0751	0.0741	0.0471	0.0380
A3	0.0385	0.0751	0.0741	0.1178	0.0761
A↓	⋮	⋮	⋮	⋮	⋮
A100	0.0385	0.0601	0.0296	0.0236	0.0190
A101	0.0385	0.0300	0.0741	0.0471	0.0571
A↓	⋮	⋮	⋮	⋮	⋮
A200	0.0192	0.0450	0.0593	0.0942	0.0380
A201	0.0192	0.0601	0.0148	0.0471	0.0761
A↓	⋮	⋮	⋮	⋮	⋮
A389	0.0770	0.0601	0.0148	0.0236	0.0571
A390	0.0385	0.0300	0.0741	0.0471	0.0571

Furthermore, the calculation of reference points results each criterion and assigning values to alternatives to the other RR and ROD methods are presented in the Figure and table as follows:

2) Reference point calculation results: Moora-RR

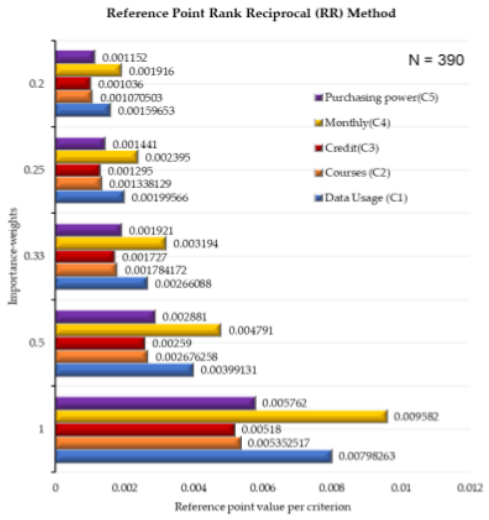

Fig. 5. Reference point for the rank-reciprocal method

Table- VII: Reference point Moora-RR method

Alter-native	Data Usage	Courses	Credit courses	Monthly Cost	Purchasing Power
	max	*max*	*max*	*min*	*min*
A1	0.0280	0.0883	0.0862	0.0439	0.0296
A2	0.0350	0.0883	0.0862	0.0439	0.0370
A3	0.0350	0.0883	0.0862	0.1756	0.0740
A↓	⋮	⋮	⋮	⋮	⋮
A100	0.0350	0.0441	0.0215	0.0351	0.0296
A101	0.0350	0.0221	0.0862	0.0439	0.0493
A↓	⋮	⋮	⋮	⋮	⋮
A200	0.0280	0.0294	0.0431	0.0878	0.0370
A201	0.0280	0.0441	0.0172	0.0439	0.0740
A↓	⋮	⋮	⋮	⋮	⋮
A389	0.0700	0.0441	0.0172	0.0351	0.0493
A390	0.0350	0.0221	0.0862	0.0439	0.0493

3) Reference point calculation results: Moora-ROC

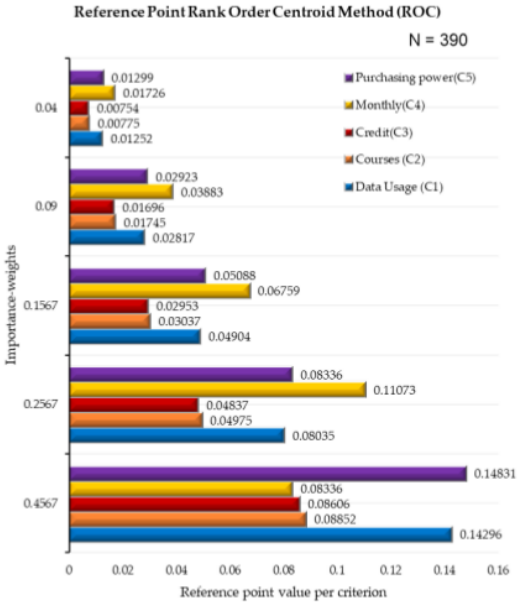

Fig. 6. Reference point for rank-order-centroid method

Table- VIII: Reference point Moora-ROC method

Alter-native	Data Usage	Courses	Credit courses	Monthly Cost	Purchasing Power
	max	*max*	*max*	*min*	*min*
A1	0.0125	0.0882	0.0861	0.0387	0.0130
A2	0.0282	0.0882	0.0861	0.0387	0.0292
A3	0.0282	0.0882	0.0861	0.1963	0.0834
A↓	⋮	⋮	⋮	⋮	⋮
A100	0.0282	0.0496	0.0170	0.0172	0.0130
A101	0.0282	0.0174	0.0861	0.0387	0.0509
A↓	⋮	⋮	⋮	⋮	⋮
A200	0.0125	0.0303	0.0484	0.1103	0.0292
A201	0.0125	0.0496	0.0075	0.0387	0.0834
A↓	⋮	⋮	⋮	⋮	⋮

A389	0.0803	0.0496	0.0075	0.0172	0.0509
A390	0.0282	0.0174	0.0861	0.0387	0.0509

After we get the reference point value from each method (RS, RR, ROC), the next step is calculate the optimization value using (7). The results of this calculation are the performance values of the alternatives and then sorted from highest to lowest. in "Table IX" are 22 alternatives selected the results of five performance methods.

Table- IX: Performance of the moora-rank methods

Rank	Moora-RS		Moora-RR		Moora-ROD	
1st	A189	0.0636	A205	0.00573	A304	0.1060
2nd	A17	0.0627	A304	0.00570	A205	0.1041
3rd	A304	0.0591	A124	0.00558	A124	0.1007
4th	A185	0.0584	A75	0.00532	A189	0.0970
5th	A27	0.0546	A189	0.00516	A17	0.0963
6th	A4	0.0537	A17	0.00512	A75	0.0934
7th	A205	0.0536	A27	0.00468	A27	0.0841
8th	A124	0.0528	A4	0.00464	A4	0.0834
9th	A10	0.0520	A10	0.00456	A10	0.0811
10th	A13	0.0520	A13	0.00456	A13	0.0811
11th	A24	0.0483	A24	0.00455	A15	0.0789
12th	A15	0.0482	A15	0.00451	A322	0.0789
13th	A322	0.0482	A322	0.00451	A24	0.0788
14th	A42	0.0478	A20	0.00447	A20	0.0782
15th	A20	0.0473	A26	0.00447	A26	0.0782
16th	A26	0.0473	A11	0.00446	A263	0.0769
17th	A224	0.0456	A263	0.00443	A1	0.0762
18th	A292	0.0452	A2	0.00441	A9	0.0762
19th	A263	0.0444	A12	0.00441	A2	0.0761
20th	A54	0.0437	A18	0.00441	A12	0.0761
21st	A349	0.0437	A28	0.00441	A18	0.0761
22nd	A11	0.0436	A30	0.00441	A28	0.0761

Table IX are the results of the performance of the three methods, we present the 22 alternatives from the 390 total alternatives. The values obtained from each method are in a different preferences order.

C. Accuracy and Precision Performance Test

Tests are carried out using the confusion matrix by matching the number of alternative attributes that are selected between the results of each ranking method with the actual data results.

Table X is the actual data of students, who are an alternative in the student category need a lot of data packages for online learning, they have a lot of courses and credits, but the economic cost ability and purchasing power for data packages is very minimal (underprivileged), the sequence of these alternative data presented based on least-able order as priority beneficiaries.

Table- X: Actual alternative data for assistance targets

Order	Alternative	Point	Order	Alternative	Point
1st	A17	23	12th	A26	21
2nd	A185	23	13th	A42	21
3rd	A189	23	14th	A48	21
4th	A4	22	15th	A92	21
5th	A10	22	16th	A124	21
6th	A13	22	17th	A158	21
7th	A27	22	18th	A192	21
8th	A304	22	19th	A205	21
9th	A15	21	20th	A224	21
10th	A20	21	21st	A322	21
11th	A24	21	22nd	A338	21

The main target of internet data assistance is to prioritize 22 students with very high needs for internet data, courses and credits, with the monthly cost and the purchasing power data in the very low category. Then it refers to the alternative actual data from "Table IX" and the selected data from the three methods (see Table X) comparable to how accurate, precise and error rate.

Table- XI: Ranking results methods and actual data

Aktual	RS	RR	ROD	Aktual	RS	RR	ROD
A17	1	1	1	A26	1	1	1
A185	1	1	1	A42	1	1	1
A189	1	1	1	A48	1	1	1
A4	1	0	1	A92	1	1	1
A10	1	1	1	A124	1	0	0
A13	1	1	1	A158	1	0	0
A27	1	1	1	A192	0	0	0
A304	1	1	1	A205	0	0	0
A15	1	1	1	A224	0	0	0
A20	1	1	1	A322	0	0	0
A24	1	0	1	A338	0	0	0
				TP	17	13	15
				TN	368	368	368
				FP/N	5	9	7

Table -XII: Confusion matrix test

Metrics	Rank Sum (SR)	Rank Reciprocal (RR)	Rank Order Centroid (ROD)
Accuracy	0.987179	0.976923	0.982051
Precision	0.772727	0.590909	0.681818
Error rate	0.04359	0.033333	0.03846

Based on the test results using confusion matrix in three rank methods the order is obtained in "Table XII", The ranking method that has the highest accuracy is SR with an accuracy difference of 0.005128 higher than the ROD and RR methods. Likewise in precision testing, the RS method has a better precision value than other methods, which is an

average of 0.772727 or the difference is 0.090909 with the error rate 0.04359. Spread the points of the results of each method to the actual results are represented in the scatter graph as in "Figure 7 and 8".

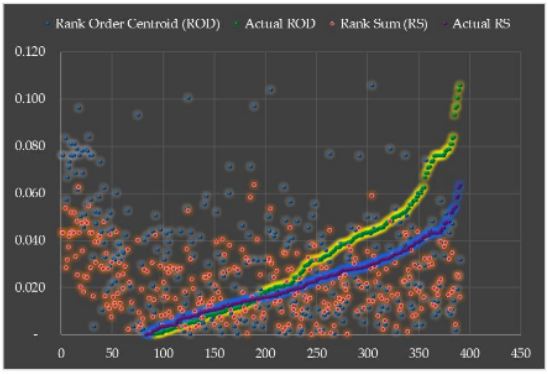

Fig. 7. Scatter graph RS - ROD toward actual data

The scatter graph in "Figure 7" explains the points of each alternative ranking from the RS and ROD method on actual results. The purple dots are the actual results forming a straight line and the red dots are the result of the RS method. On the graph the horizontal line is the ranking order and the vertical line is the expected order value.

Because the expected order is exactly the same as the real result then, the real yield dots (purple dots) directly proportional to the expected results. Meanwhile, the RS results points (red dots) are spread out according to the RS ranking position against the expected results. For example, in the 1st order the RS method results in the A189 order on the expected results so that the position of the red dot that is formed is at (x, y) equal to 0.0635.

Likewise, the RR scater graph "Figure 8", explain that the points of each ranking on the alternative method results to the actual data.

Fig. 8. Scatter graph rank reciprocal – actual data

D. Discussion

Online learning from home as one of the consequences of the Covid-19 pandemic has made it difficult for students to finance internet data packages. Various efforts by the Government and educational institutions in Indonesia in the form of social assistance programs are channeled, and one of them is internet data package assistance to students to support the learning process to keep it running well. However, in the distribution of such data assistance, the determination of the equal weight, and provide the same proportion of assessments for each criterion and sub-criteria (indicator) of the component of potential beneficiaries.

In fact, there is a possibility that a criterion has a more dominant and important role in determining the data structure of the assessment component. Therefore, this study proposes an important weighting method approach with analytical studies and to test the performance of the method. Different weighting systems will have an impact on changes in value (decisions), which in turn will change the decision regarding the assignment of social assistance categories so that they are not right on target.

An important weighting method that we discussed is the implementation of the three ranking methods; Rank-Sum (RS), Rank Reciprocal (RR) and Rank Order Centroid (ROD). These three methods are simple (easy-use) and with the assessment of surrogate weights that can be determined how important these variables are to the principal of these criteria. Thus, the criteria that contribute more and are important in determining the variability of the data will have a more optimal weight compared to the criteria with a smaller contribution.

From the research results discussed in the previous section, several important points are found,ie:

The three ranking methods (RS, RR, ROD) have their respective characteristics in importance-weights, where the accuracy and precision level of the RS method is better than the RR and ROD methods (for the case: 5 criteria; 390 alternatives). Another thing is that the weighting of the important to the most important is balanced, so that the selection alternatives do not have a range of values that are too high or low (see: RS scatter chart). And the weight value of the non-benefit (cost) criteria in the Rank-Sum method has a significant effect on performance results.

The RR and ROD methods, both in the assignment of importance weight tend to be more dominant in providing a portion of the benefit criteria, the range between importance to the most importance is not balanced, so that the alternative performance values tend to be very high or very low, this can be seen from the results of the ranking. which gets a minus score(72/390 for RR, 90/390 ROD).

The characteristics of both the RR and ROD methods are very good to be applied to cases where the non-benefit (cost) factor. This is what causes the level of precision and accuracy of the 2 methods to be lacking, as in the case study of data package assistance, there are 2 non-benefit (cost) criteria which significantly affect accuracy, precision and best performance only if the alternative with the benefit criteria (max) is high.

IV. CONCLUSION

The importance of a parameter can be seen from how much weight is given to it in the decision-making process. In determining the method and importance-weight for the case of social assistance management according to the needs (proportion) and the objectives target of the assistance, this has an influence on the performance value of accuracy and precision. Internet data package assistance for students is a case study of how the performance of the ranking method is applied. and the research results have provided interesting things to be studied further.

The three methods used (Rank-Sum, Rank Reciprocal, and Rank Order Centroid) in management social assistance we explain that of the 390 alternatives with a target (preference) it is expected that 22 potential beneficiaries, obtained an error rate of 3% -4%, with a precision of 17/22, 15/22 and 13/22 (RS, ROC, RR). Furthermore, the performance accuracy value of the 3 methods ranges from 97 - 98%. The study results still require better performance optimization, given that, these case study social assistance very important for being able to reduce the error rate value and with a better precision value cause the social assistance is a concern to community welfare.

For that, future studies applied a variety of approaches and other importance weighting methods, and combine them with multiple-criteria decision analysis (MCDA) methods.

V. CONCLUSION

In determining the method and importance-weight for the case of social assistance management according to the needs (proportion) and the objectives target of the assistance, this has an influence on the performance value of accuracy and precision. Internet data package assistance for students is a case study of how the performance of the ranking method is applied. and the research results have provided interesting things to be studied further.

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AUTHORS PROFILE

Edy Budiman is member of the Association for Computing Machinery (ACM), member of Institute of Electrical and Electronics Engineers (IEEE), and member of APTIKOM (Asosiasi Pendidikan Tinggi Informatika dan Komputer) and mem-ber of The Institution of Engineers Indonesia (PII). Currently, he is actively teaching and researching. As a writer on several jour-nals and conferences, he focuses his research on mobile network issues, performance and mobile-based apps.

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