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Internet Data Usage Analysis During the Covid-19 Pandemic for Decision Making

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Abstract - *An the coronavirus outbreak changed everything. Including in the world of education. The first objective of this research is to provide data related to the use of internet data in online learning during the LFH Covid-19 pandemic and the second objective is decision making for internet support programs to students from the data collected. To fulfil the first objective, direct measurements are taken during the learning process, collected in a measurement scenario using the drive test method. The second objective is realized by extracting information from the collected data applying multi-criteria decision-making analysis (MCDM) models to manage student's internet data support programs.*

Key Words: internet, data usage, decision-making, covid-19

1. INTRODUCTION

This The massive spread of the coronavirus 2019 (Covid-19) in various countries forces us to see the fact that the world is changing. United Nations,(2020), explain that how the changes in technology, economy, politics and education in the midst of the crisis due to Covid-19.

UNICEF, WHO and IFRC in "COVID-19 Prevention and Control in Schools"(2020) stated that when the situation of the virus spread is getting faster, schools must be closed and the educational process must continue through online learning activities using various media. Response to this, in Indonesia country, the government issued a circular regarding the implementation of distance learning, through the Circular of the Minister of National Education Number 4 (2020) concerning education policies in the Covid-19 emergency period

The Indonesian government policy made around 217,270 schools, 4,670 higher education institutions closed. Cause there are 25.5 Million elementary school students, 10, 12 million junior high school students, 4.78 million high school students, 4,9 Vocational high schools, 130 thousand special school students (children with disabilities), and 8 million students of higher education institutions must learning from home (LFH) through online learning.

However, to implement this policy not as easy as expected. Many things cause the concept of online learning to be not optimal in its implementation, the lack of technological facilities owned (educators, students, and parents), lack of public awareness of the concept of education, literacy digital of educators still low, the unpreparedness of educators to provide a system of assignments and evaluation to students, and there are some places, certain areas that do not allow their citizens to use electricity (IT). In addition, the economic factor that presses most of the people as a result of this outbreak is an important problem because it is related to the financing (cost) of their daily needs. In particular, the cost of purchasing internet data packages to access online learning.

Internet data is an important requirement for students in online learning. Parents must provide more budget to buy. With the unstable economic situation during the Covid-19 pandemic, parents certainly have difficulty adding to the cost of internet data for their children's online learning. All educational institutions or stakeholders with various efforts have taken the best policies in maintaining the continuity of educational services and problem-solving solutions. One of the breakthroughs applied by higher education institutions as a solution in the cost issue is to provide support (subsidies) free internet data to students during the Covid-19 pandemic. This program is distributed to student telephone numbers (sim cards) with a certain amount of data per month.

Until now, learning from Home is still being implemented, as is the internet data support program for students. The higher education institutions in the research location have a very large number of students and of course, the provision of internet data for students will also be large.

The policy of the higher education management as a decision-maker in the distribution of internet data support programs to students uses an average share approach, the value of internet data received per student is all the same without measurement or calculation based on student needs analysis. This decision seems unfair, not proportional. The needs and use of data for each student are different from others, there are differences in the economic ability of students, the number of courses or the number of credits, the duration and number of meetings per month or per semester.

This research presents the results of internet data usage in online learning, such as information on data needs per course, data per credit, and meeting duration per minute. Furthermore, the application of the decision support system model uses the multi-criteria analysis method in determining the right-target and priority (student) in internet data support programs for online learning.

2. LITERATURE REVIEW

2.1 The Covid-19's Impact on Indonesia Internet Performance

Overview of Indonesia's network performance during the peak of the Covid-19 pandemic according to Ookla Speedtest (2020) Tracking - Speedtest Global Index from December 2019 to July 2020, seen in Chart 1.

Indonesia Internet Performance

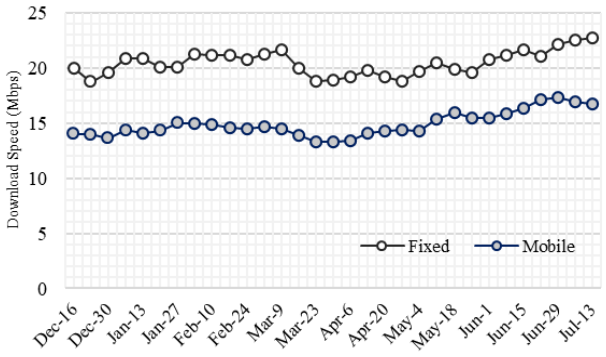

Chart 1. Indonesia internet performance dec-2019 to jul-2020

Monitoring the impact of COVID-19 on Ookla Speedtest (2020) the performance and quality of Indonesia mobile and fixed broadband internet networks, when comparing per the week such as in Figure 1, obtained an average of 14.87 Mbps for mobile and 20.43 Mbps fixed broadband. Revised network performance information in research locations regular, systematic and collection of new data is very important. Several results of network performance studies in the last 4 years, prior to the Covid-19 outbreak have been reviewed by the authors presented in the study Budiman, E. et al (2017). Network performance before the pandemic vs. during the pandemic. Internet traffic spikes increased by 13% - 20%, traffic increased by 13% at night, and during the day increased 20% compared to average traffic. There is a government policy "Working - Learning from Home (WFH - LFH)", the increase in traffic was dominated by the growth of users of online learning applications.

2.2 Multi-criteria decision making for internet support programs to students

According to Triantaphyllou, E. et al (1998) There are many techniques that can be used in solving decision-making cases that have many criteria, such as the Multi-criteria Decision Making (MCDM) method. MADM is the most well-known branch of decision-making from the general class of operations research models that deal with decision problems under a number of decision criteria. And refers to Vinogradova, I. (2019) and Ding, T, et al (2016) the MADM approach requires that the selection be made among decision alternatives described by its attributes, the problem is assumed to have a number of predetermined decision alternatives.

The MADM approach can be viewed as an alternative method for combining information in the problem decision matrix together with additional information from the decision-maker to determine the final ranking or selection among alternatives[3]. Some of the techniques described in Wati, M. et al (2018), and Budiman, E. et al (2018) i.e.: Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytic Hierarchy Process (AHP) technique, ELECTRE, SMART Technique and others.

The decision making for the internet support program for students uses SAW methods. These methods were selected according to the case study based on the predetermined value of the criteria and preference weights (benefit and cost), the ranking process selects the best alternative from a number of alternatives (student).

3. METHODOLOGY

An overview research design is shown in Figure 1.

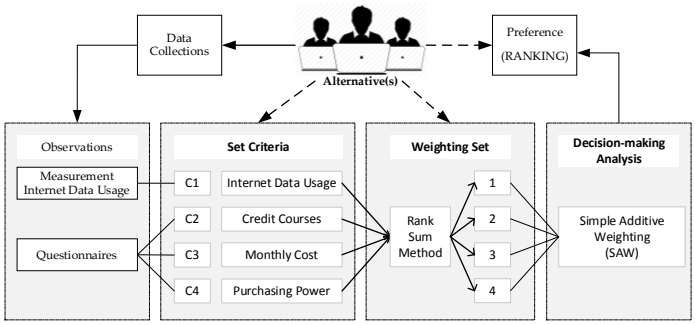

Fig. 1. Research design for internet data usage analysis and decision-making

3.1 Data Collection Methods

Data collection through field observation(survey), ie. Data collection with measuring the amount of internet data usage, and questionnaires. The internet data measurement using the drive test methodology, the equipment and tools used are presented in Table 1.

Table -1. Equipment and tools to measure data usage

Equipment	Specifications
PC or Laptop Platforms	2.5 GHz Dual Core Intel Core i5 8GB-4GB 2666MHz DDR4-Memory
Android / Smartphone-Tablet	Android OS: Android 4.0 and above Screen size: 6-8.0 inch
GlassWire Apps	Current-ver. 3.0.354r

ZOOM Cloud	Current-ver 5.2.4 H.323/SIP room-systems

The questionnaire involved 100 undergraduate students at the Informatics department - Mulawarman University, Indonesia.

Drive-test Method, measurements were taken for the live streaming of the Zoom apps which is used as an online learning from home during the Covid-19 pandemic, with a scenario as in Table 2.

Tabel -2. Equipment and tools to measure data usage

Scenario	Meeting duration	Room	Students
1	15 minute	A	20
	30 minute	B	20
2	45 minute	C	30
	60 minute	D	30

Scenario 1: the number of participants is 20 students with a meeting duration of 15 minutes for classroom A and 30 minutes for classroom B.

Scenario 2: The number of participants is 30 students with a meeting duration of 45 minutes for classroom C and 60 minutes for classroom D.

The measurement scenario is set to determine the amount of internet data usage per duration, to calculate the amount of data usage per minute. In addition, to determine the difference in data usage between the number of participants and the duration of the meetings.

3.2. Variable Analysis (Criterion)

The data collection results obtained through observation (measurement and questionnaires) are used as criteria for analysis of decision making(DM).

There are 4 criteria that are used as a reference in DM to internet data support program for students, ie: student data usage (C1), Credit courses(C2), Economic cost ability(C3) and Data purchasing power(C4). The criterion set as in Table 3.

Tabel -3. Set Criterion, Crisp value

Criteria	Rating set	Descriptions
C1	10 Gb – 12 Gb 12 Gb – 14 GB 14 GB - 16 GB 16 GB – 18 GB	The amount of student internet data needs per week basing on the measurement results of the drive-test during online learning from home
C2	14 – 16 16 – 18 18 – 20 20 – 22 22 - 24	Number of student academic credits (1 credit = 45-60 minutes)
C3	1.000.000 – 2.000.000 2.000.000 – 3.000.000 3.000.000 – 4.000.000	Student's monthly living expenses provided by their parents in IDR Indonesia
C4	100.000 200.000 300.000 400.000 500.000	Student expenses for purchasing online learning internet data packages for a month in IDR Indonesia

3.3 Decision Making Analysis: Simple Additive Weighting (SAW)

The decision-making analysis in the management of student's internet data support programs using the Simple Additive Weighting (SAW) method. Steps to Solve SAW method refers to Afshari, A. et al (2010), show in Figure 2.

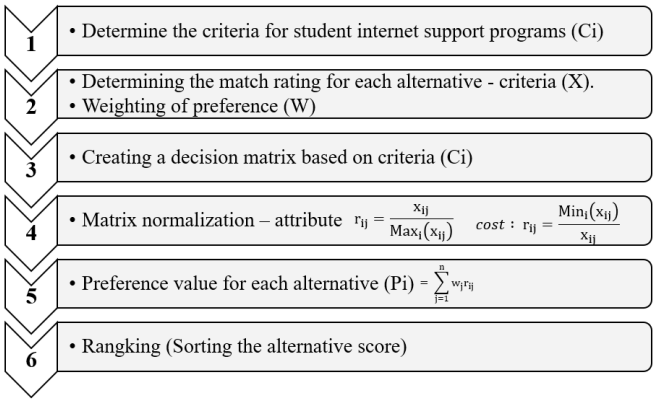

Fig. 2. The algorithm for solving the SAW methods

3.4 Weighting Criterion

The importance of a criterion can be seen from how much weight is given to it in the decision-making process, In this study, to weight the criteria using the Rank-Sum (RS) method. The ranking method is the simplest method for assignment a weighted value. The weighting using the RS method refers to Fishburn, P.C. (1967) and Deng, L. et al (2004) is calculated in the eq. (1):

$$wj = \frac{(n - rj + 1)}{\Sigma(n - rc + 1)} \quad (1)$$

The *wj* is the normal weight for criterion j (j = 1,2 ... n), n is the number of criteria, c is criteria (c = 4) and rj the ranking position of a criterion (importance-weight). Each criterion is assigned a weight of (n - rj + 1) and then normalized by Σ (n - rc + 1).

4. RESULT AND DISCUSSION

This study aims to provide information on the amount of internet data usage in students' online learning during the learning from home Covid-19 pandemic and the use of multi-criteria decision-making methods in internet support programs to students from the data collected. To meet this objective, direct measurements were taken during the learning from home process, collected in a measurement scenario using the drive test method. Furthermore, the information from the data collected becomes the criteria in the multi-criteria decision making (MCDM) internet support program for students.

4.1 Result: Measurement of Internet Data Usage

The results of the drive-test measurement of student's internet data usage are divided into 3 measurement scenarios, i.e:

Scenario 1: Set 15 minutes and 30 minutes

Measurement of data usage with the duration of the meeting is set to 15 minutes and 30 minutes, with 20 students each. The measurement results are presented in the Chart 2 in the following Table 4.

Tabel 4. Data usage for scenario 1 set 15 minutes

Students	Incoming (Mb)	Outgoing (Mb)	Total Data Use (Mb)
User1	99.40	50.70	150.10
User2	125.80	36.90	162.70
User3	170.20	34.10	204.30
⋮	⋮	⋮	⋮
User19	137.60	28.43	166.03
User20	124.40	45.30	169.70
Avg.	140.81	40.31	181.12
Min	95.70	18.20	131.80
Max	185.90	72.20	238.60

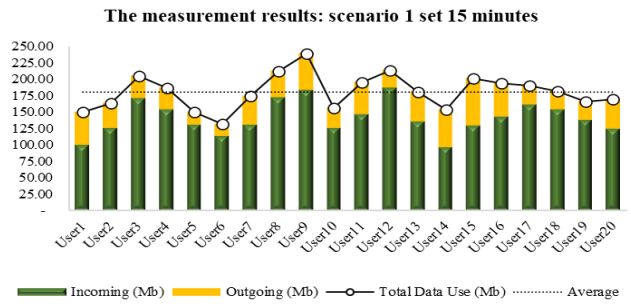

Chart -2. The amount of data usage for scenario 1 set 15 minutes

The results of the measurement for scenario 1 set of 15 minutes in Chart 4, show the information on the amount of internet usage for 20 students, the average incoming value is 140.72 Mb, and outgoing 39.74Mb. Thus, the total average value of data usage is 180.46MB for 15 minutes of meeting duration. Furthermore, the detailed values can be seen in Table 4.

The use of internet data from 20 students with a value of min incoming 95.70Mb and outgoing 18.20Mb, for max incoming 185.90Mb and outgoing 72.20Mb. So, the total min data usage value is 131.80MB and the max is 238.60MB.

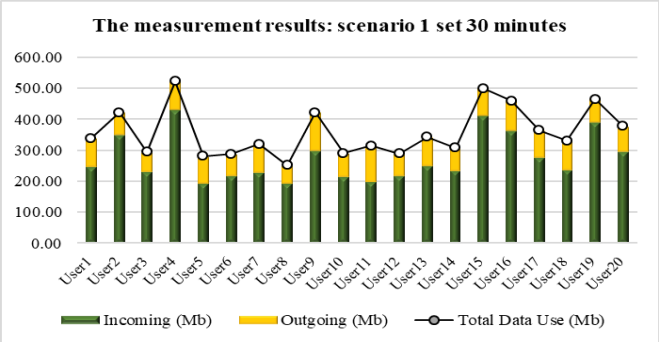

Chart -3. The amount of data usage for scenario 1 set 30 minutes

The results of the measurement for scenario 1 set of 30 minutes in Chart-3, show the information on the amount of internet usage for 20 students, the average incoming value is 274.78 Mb, and outgoing 84.04Mb. Thus, the total average value of data usage is 358.82Mb for 30 minutes of meeting duration.

Tabel 5. Data usage for scenario 1 set 30 minutes

Students	Incoming (Mb)	Outgoing (Mb)	Total Data Use (Mb)
User1	248.40	89.80	338.20
User2	349.38	73.26	422.64
User3	232.32	61.90	294.22
⋮	⋮	⋮	⋮
User19	389.79	74.80	464.59
User20	297.20	79.90	377.10
Avg.	274.78	84.04	358.82
Min	193.50	57.01	251.13
Max	430.10	121.23	522.20

The use of internet data from 20 students in Table 5 (scenario 1 set of 30 minutes) with a value of min incoming 193.50Mb and outgoing 57.01Mb, for max incoming 430.10Mb and outgoing 121.23Mb. So, the total min data usage value is 251.13Mb and the max is 522.20MB

Skenario 2: 40 minutes and 60 minutes

Measurement of data usage with the duration of the meeting is set to 45 minutes and 60 minutes, with 30 students each. The measurement results are presented in the Chart -4 in the following Table 6.

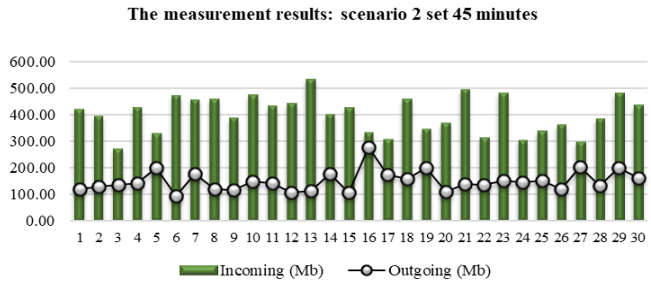

Chart -4. The amount of data usage for scenario 2 set 45 minutes

The results of the measurement for scenario 2 set of 45 minutes in Chart -4, show the information on the amount of internet usage for 30 students, the average incoming value is 392.02 Mb, and outgoing 148.50Mb. Thus, the total average value of data usage is 540.52Mb for 45 minutes of meeting duration**.**

Tabel -6. Data usage for scenario 2 set 45 minutes

Students	Incoming (Mb)	Outgoing (Mb)	Total Data Use (Mb)
User1	417.20	118.70	535.90
User2	389.18	128.24	517.42
User3	266.52	135.00	401.52
⋮	⋮	⋮	⋮
User29	478.30	198.20	676.50
User30	432.90	160.83	593.73
Avg.	392.02	148.50	540.52
Min	266.52	91.82	394.61
Max	530.81	276.30	676.50

The use of internet data from 30 students with a value of min incoming 266.52Mb and outgoing 91.82Mb, for max incoming 530.81Mb and outgoing 276.30Mb. So, the total min data usage value is 394.61Mb and the max is 676.50Mb.

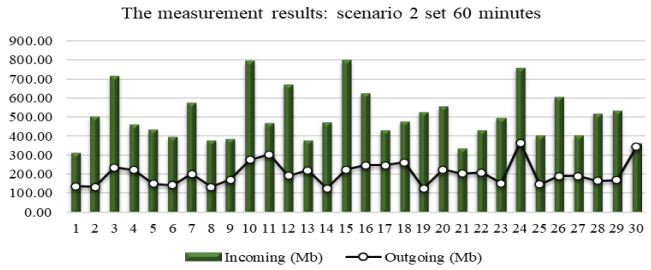

Chart -5. The amount of data usage for scenario 2 set 60 minutes

The results of the measurement for scenario 2 set of 60 minutes in Chart -5, show the information on the amount of internet usage for 30 students, the average incoming value is 500.76 Mb, and outgoing 203.07Mb. Thus, the total average value of data usage is 703.83Mb for 60 minutes of meeting duration.

Tabel 7. Data usage for scenario 2 set 60 minutes

Students	Incoming (Mb)	Outgoing (Mb)	Total Data Use (Mb)
User1	306.96	135.20	442.16
User2	495.22	132.61	627.83
User3	709.61	234.61	944.22
⋮	⋮	⋮	⋮
User29	527.30	169.10	696.40
User30	356.60	342.71	699.31
Avg	500.76	203.07	703.83
Min	306.96	125.42	442.16
Max	793.33	365.34	1.118.27

The use of internet data from 30 students with a value of min incoming 306.96Mb and outgoing 125.42Mb, for max incoming 793.33Mb and outgoing 365.34Mb. So, the total min data usage value is 442.16Mb and the max is 1.118.27Mb or 1.11Gb.

4.2 Result: Decision Making Analysis

The research sample for which is an alternative decision making for internet data support programs is informatics undergraduate 158 students academic year 2019. The descriptive statistics of students are presented in Table 8.

Tabel 8. The descritive statistics alternative (students)

N:158	(C1)	(C2)	(C3)	(C4)
Mean	137554.60	234177.21	1679651.90	19.2025
Median	136103.80	300.000	1.400.000	19.00
Mode	128940.44	300.000	1.000.000	18.00
Min.	100287.01	100.000	1.000.000	14.00
Max.	171920.59	500.000	4.000.000	24.00

Implementation of the Simple Additive Weighting (SAW) method in MCDM.

Steps 1: Alternatives and Criteria:

Tabel 9. Determination of the match rating alternative (student) to the criteria

Altenative	C1	C2	C3	C4
Student1	17,192	24	3,500,000	200.000
Student2	10.028	14	2,500,000	400.000
Student↓...	...	..	..	..
Student157	12,894	18	1.200.000	400.000
Student158	15,759	22	2.100.000	300.000

Step 2: Decision Matrix (X) :

$$\begin{vmatrix} 17{,}192 & 24 & 3{,}500{,}000 & 200.000 \\ 10{,}028 & 14 & 2{,}500{,}000 & 400.000 \\ \vdots & \vdots & \vdots & \vdots \\ 12{,}894 & 18 & 1.200.000 & 400.000 \\ 15{,}759 & 22 & 2.100.000 & 300.000 \end{vmatrix}$$

Step 3: The matrix normalized (R):

To get the normalized matrix value (R), it is necessary to set the attribute (cost or benefit) of the criteria, as shown in the Table 10.

Table 10. Set attribute (cost or benefit) and weights (w) of the criteria

Criteria		Attribute	Set weights (W)	
			Rank sum	Importance
C1	Student data usage	Benefit	0.4	1
C2	Credits courses	Benefit	0.3	2
C3	Economic cost ability	Cost	0.2	3
C4	Data purchasing power	Cost	0.1	4

The matrix normalized (R) :

$$\begin{vmatrix} 1.000 & 1.00 & 0.50 & 0.29 \\ 0.583 & 0.58 & 0.25 & 0.40 \\ \downarrow & \vdots & \vdots & \vdots \\ 0.750 & 0.75 & 1.00 & 0.83 \\ 0.917 & 0.92 & 0.25 & 0.48 \end{vmatrix}$$

Step 4: Calculation of preference value (P)

The preference value (P) is obtained from the sum of the multiplication of the normalized value (R) with the criterion weight (W) for each Alternative (A). Value calculation result shown in Chart -6.

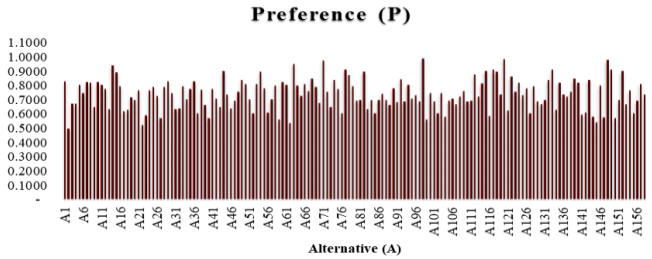

Chart -6. The preference value SAW method

Step 5: Rangking

From the results of the calculation preference value (P), then ranking is carried out by sorting by the largest value to the smallest value, which is show in Chart 7 and Table 11.

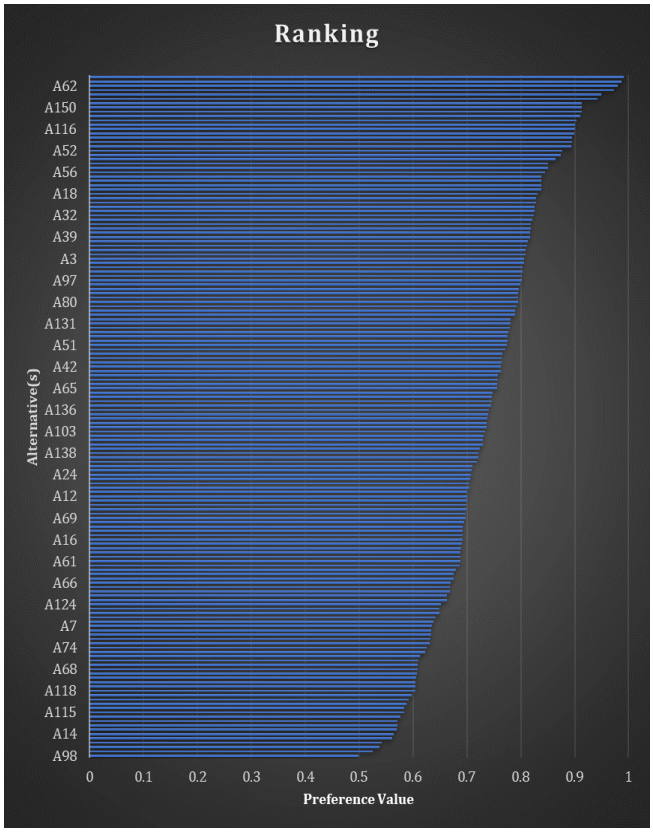

Chart -7. Rangking

Table 11. Ranking

Preference			Rangking		
Altenative	Value		Altenative	value	Order
A1	0.8286		A98	0.9913	1
A2	0.4983		A120	0.9870	2
A3	0.6756	➲	A148	0.9800	3
A4	0.6750	Sort	A71	0.9735	4
A5	0.8067		A63	0.9500	5
A...	...		..	..	..

A157	0.8083	A22	0.5250	157
A158	0.7393	A2	0.4983	158

Thus, the result of Alternative A98 with a value of 0,9913 is the 1st rangk, followed by the A120 (2nd), A148 (3rd), and so on, with the highest to the lowest ranking preference value (descending).

4.3 Discussion

Discussion: Internet Data Usage Analysis:

Principle, scenarios for measuring internet data usage, designed to see the behaviour of the data on the duration of the meeting and the number of participants. The range of values between incoming and outgoing data is very large.

In our monitoring during the learning process, the difference in incoming vs outgoing values is due to some user activity during learning, such as the use of media features, the types of modules or material files presented by participants, and including the activities of participants checking or viewing (opening) accounts - the windows of other participants, also have an effect. The use of video and audio (enable) during learning is one of the things that cause large data usage. Furthermore, a summary of the results of using data from the scenario is shown in the Table 12.

Based on Table 12, presenting data usage for the set duration of 15 minutes (20 students) obtained an average value of 12,156 Mb per minute, for a duration of 30 minutes of 11,857 Mb per minute, duration of 45 minutes (30 students) of 12,011 Mb, and duration of 60 minutes. Obtained a value of 11,730 Mb. If we substitute the value for hours, then the value range is 703,834 Mb - 729,382Mb, or on average the value is 716,336 Mb per hour or 11,938 Mb per minute.

Tabel 12. Summary of measurement results using data in online learning

Set scenario	Incoming (Mb)	Outgoing (Mb)	Total data usage (Mb)	Avg. perminutes (Mb)	Data usage per-hour (Mb)
15 min (20)	142.05	40.294	182.345	12.15	729.38
30 min (20)	269.60	86.108	355.71	11.85	711.43
45 min (30)	392.020	148.501	540.52	12.011	720.69
60 min (30)	500.76	203.07	703.83	11.730	703.83
Average				11.93	716.33

Discussion: Decision making Analysis – SAW method

The basic concept of the SAW method is to find the weighted summation of the performance rating on each alternative on all attributes. SAW can be considered as the easiest and most intuitive way to solve problems Multiple Criteria Decision-Making because the additive linear function can represent the preferences of the decision-maker. Based on the results of using the SAW method in the internet data support program, 158 students and 4 criteria were obtained, the preference values were sorted (ranking) from highest to lowest.

Internet data support program for students is assistance targeted for all students in supporting online learning from home during the Covid-19 pandemic so that subsidies for distributing internet data are proportionate to student needs.

Tabel 13. Setting the group and class interval according to student rangking

Group	Class interval (preference value)	Frequence	Ranking	Percent (%)
1	0.868 - 0.991	10	1 to 10	6.33
2	0.744 - 0.868	38	11 to 48	24.05
3	0.621 - 0.744	74	49 to 122	46.84
4	0.498 - 0.621	36	123 to 158	22.78
Total		158		100

In order to facilitate the distribution of internet data assistance to students, thus, class intervals (grouping) were arranged using the Likert scale technique. The results for the interval class are presented in Table 13.

Class grouping based on Table 13 is expected to provide convenience to all stakeholders in the decision-making process for distributing internet data assistance according to learning needs, and the economic ability of students in proportion and right on target. With the assistance program that the government and educational institutions distribute, it is hoped that it can ease the burden on parents of students during this pandemic.

5. CONCLUSIONS

This research is a follow-up to the emergence of new problems that arise in the distribution of support programs to be right on target. The decision-making approach method presented by the author is one solution that can be applied in program management. The results of this study provide information that can be additional knowledge for the general public regarding the use of data in online learning, in particular, the use of data in the Zoom cloud meeting

application which is now popular and generally widely used by educational institutions in Indonesia.

From the results of the drive-test measurement, the average value of data consumption per hour was 716.336Mb (11.939Mb per minute) in the range 442.16Mb - 1.118Gb, with the number of participants 20-30 students. The results of this measurement, corroborate the experiments conducted by Lauren Hannula(2019), 540MB / 810MB - 2.4GB per hour for group meetings).

Research on data, networks and their performance will never run out to be discussed and researched, more experiments are still needed, given that the network issue is not just about the implementation of the use of technology and its convenience, but also have an impact on the sector economic society related to the issue of internet data usage

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