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Analysis of Internet Service Provider Selection Using the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) Methods

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Abstract
Currently, the need for an internet connection is increasing due to the human need for information and communication that can be obtained through the internet. A decision support system with criteria is needed to solve the challenge of choosing an internet package with many components or criteria that must be evaluated. Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) are two multi-criteria decision support system techniques, but they use different measurement techniques. This research aims to identify the best Internet Service Provider by applying the Simple Additive Weight (SAW) and Analytic Hierarchy Process (AHP) techniques. The objects used in this research are the providers Indihome, Biznet, and Solnet. The weight of each criterion is determined using the AHP technique, and the best suppliers are ranked using the SAW approach. The sampling technique used in this research was Purposive Sampling. In this study, the ranking results of 100 respondents showed that the ranking for the AHP method was 60% and for the SAW method was 92%. Thus, global calculations using the AHP and SAW methods were obtained for the best alternative ISP, namely Indihome.
Keywords: Analytic Hierarchy Process, Simple Additive Weight, Internet Service Provider.

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INTRODUCTION

Each service provider is expected to understand the needs and preferences of potential users due to the large number of mobile operators available today. Each operator is expected to create a competitive advantage that can attract customers' attention. Customers will choose the service that best suits their needs in terms of quality, price, and features. With the increasing need for internet network services in Indonesia every year, many Internet Service Provider markets are competing to offer a variety of internet packages and services that are attractive to consumers. According to research conducted by Velte et al. (2008) Internet Service Providers act as intermediaries between users and the global internet, enabling users to connect to internet networks and access various online services. Network quality criteria are the criteria most considered by students in choosing a provider card, followed by quota criteria, price, bonuses, and ease of use. (Zistiani, 2023)

Internet services can be available in various places, which makes it easier for people to use them for daily online activities wherever they want. Choosing the internet service provider to use ultimately meets your needs. There are services with relatively expensive prices but good quality, or services with relatively affordable prices but not too high bandwidth. These various advantages will make it more difficult for users to choose which internet service they will use. The solution to help people choose internet services is to use the Analytical Hierarchy Process (AHP) as a decision support system. (Amos Saut Parulian Aritonang, 2023)

Several other high-speed Internet Service Providers with the latest technology available in Indonesia such as; Biznet high-speed internet provider with TV services; Solnet which provides unlimited internet packages; IndiHome which provides internet services and telecommunications services and Republikku offers cheaper prices compared to other internet service providers, speeds varying from 50Mbps to 300Mbps.

To fulfill their needs, the above providers offer services at competitive prices and speeds. The sheer number of choices makes it difficult for consumers to decide. In addition, the competitive market dynamics of internet service providers also mean that consumers have to deal with continuous changes to the internet services offered. Sometimes, companies will introduce special offers or promotions that further confuse consumers in making decisions. This complexity can lead to consumers feeling confused, unsure, or even regretful after choosing a particular Internet Service Provider. Moreover, a mistake in choosing an Internet Service Provider can result in inefficient spending and an unsatisfactory internet experience. The priority criteria that influence the selection of mobile operators based on overall respondent data is the speed of internet access (Fathulhanif Salman Zainurrisalah, 2024)

This complexity is overcome by multi-criteria decision analysis, carried out by the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW). According to by Utama, (2017, bk. 114) suggests that the Analytical Hierarchy Process (AHP) allows people to organize and compare various criteria in a hierarchy, while according to research by Maryani et al. (2020, pt. Fisburn & MacCrimmon (2017) states that Simple Additive Weighting (SAW) uses a criteria weight ranking approach. These two methods help make a smarter choice when choosing an Internet Service Provider.

Additionally, research (Medyati, 2019) found that Thomas L. Saaty created the Analytical Hierarchy Process (AHP) method as a tool to assist decision-making, and also to enable decision-making about how to organize complex problems into an integrated structure or series of levels. On the other hand, the Simple Additive Weighting (SAW) method calculates the weighted sum of the performance values of each option for each criterion. Therefore, these two methods are needed to complete the Internet Service Provider selection process which is intended to help make multi-criteria decisions.

In the process of selecting an Internet Service Provider, this research aims to apply and compare the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods. Thus, we will find out how these two methods can help potential customers make choices that are more in line with their wishes. Additionally, this research will teach internet

service providers about the elements that are most important to customers when selecting an Internet Service Provider. Service providers can use this information to improve their offerings and better understand their customers' needs.

With this background, this research entitled Analysis of Internet Service Provider Selection Using the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) Method, is expected to provide a better solution in the Internet Service Provider selection process which will ultimately increase customer satisfaction and cost efficiency. The results of this study contribute information for the public to choose a provider that suits their needs. This research contributes information and input to internet service providers in determining future business strategies.

RESEARCH METHODS

The Internet Service Provider selection process will be analyzed using quantitative descriptive research using the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methodology. The information collected for this research will relate to the standards and options used when selecting an Internet service provider. Each of these variables is measured using a Likert scale, for example, the value ranges from 1 to 10 in the Simple Additive Weighting (SAW) method. The object of this research is the general public who use Internet Service Provider (ISP) services and who live in Batam City

Operational research indicators encompass various measurable criteria to evaluate the performance of each Internet Service Provider. These indicators or criteria include connection speed, network reliability, pricing and service packages, customer service quality, coverage area, network security, availability of additional services, and customer satisfaction

Table 1. Research Indicators

Research Concept	Indicators/Criteria	Scale
Selection of Internet Service Provider	Connection Speed	Likert
	Network Reliability	Likert
	Prices and Service Plans	Likert
	Quality of Customer Service	Likert
	Coverage Area	Likert
	Network Security	Likert
	Customer Satisfaction	Likert

The type of data used in this research is known as primary data, according to Sugiyono (2019, p. 225). Questionnaires distributed to respondents are used to obtain the information they need. The data source for this research is the general public of Batam City who were respondents to answer statements from the questionnaire that generally the public understands and uses internet services. The object of the research is the general public using Internet Service Provider Broadband services who live in the Batam City area. Because the population size is unlimited or unknown, the Lemeshow formula is the method used to calculate the number of samples that will be used in this research. With the following formula, the sample size is as follows:

$$n = \frac{Z^2 1 - \alpha/2p(p-1)}{d^2}$$

$$n = \frac{1{,}96^2 \times 0{,}5(1-0{,}5)}{0{,}1^2}$$

$$n = \frac{3{,}8146 \times 0{,}25}{0{,}01}$$

$$n = 96{,}04$$

The more the sample, the better the statistical power. The next reason the sample was taken to be 100 respondents was that the sample size was not less than the minimum sample that had been determined. If the subject is less than 100, then it is better to take all (Arikunto, 2014). The reason the sampling is rounded up to 100 is because if the sample is larger the results will be better, so the sample calculation result of 96.04 is rounded up to 100 respondents.

According to Sugiyono (2012), the sample is a component of the total population and its characteristics. The sampling process must truly be used as an illustration or representation of the actual condition of the population. The purposive sampling method, which takes samples based on certain considerations, was used in this research. The considerations used to become respondents are:

1. Respondents aged <24 years to >40 years (minimum 18 years and maximum 50 years), because at this age respondents can provide accurate and reliable data.
2. Respondents are Internet Provider Broadband service users
3. Respondents live in the Batam City area.

The Analytical Hierarchy Process (AHP) approach was developed in 1970 by Thomas L. Saaty, a mathematician from the University of Pittsburgh in the United States. This decision support model will provide an explanation of the elements, further criteria, or multifactorial complexity arranged in a hierarchy. Reassessment needs to be done if the CR value is more than 0.1. The CR formula is:

$$CR = \frac{CI}{RI} \qquad (2)$$

Information:
CR = Consistency Ratio
R.I = Index Random

Consistency Ratio value (CR) and Consistency Index (CI) were calculated to test the Analytical Hierarchy Process (AHP) approach.

The SAW method is often also known as the weighted sum method. The basic concept of the SAW method is to find the weighted sum of the performance ratings on each alternative from all attributes (Fishburn, 1967). *Simple Additive Weighting*(SAW) also called the weight addition method finds the total weight by calculating the ranking for each option over all criteria Kusumadewi & Hartati (2007). The choice matrix (X) must be normalized in the Simple Additive Weighting (SAW) approach to a scale that can be compared with all currently existing alternative symbols. This approach only performs one normalization step using a matrix consisting of rows and columns. The formula to get this normalization is:

$$R_{ij} = \begin{cases} \frac{X_{ij}}{Max_i X_{ij}}, & \text{if j is a benefit attribute (benefit)} \\ \frac{Min_i X_{ij}}{X_{ij}}, & \text{If j is a cost attribute (cost)} \end{cases} \qquad (3)$$

R_{ij} is the normalized performance rating of alternative (provider) Ai in attribute Cj; i=1,2,…,m and j=1,2,…,n.

Information:
R_{ij} = Normalised performance rating
Max_{ij} = Maximum value of each row and column
$Minx_{ij}$ = Minimum value of each row and column column
Xij = Row and column of the matrix

The following is the preference value (Vi) for each alternative:

$$Vi = \sum_{j=1}^{n} (W_{ij} R_{ij}) \quad (4)$$

Information:
VI = Ranking for each alternative
Wj = Weight value in each criterion
Rij = Normalized performance value

The final result of the ranking procedure is obtained by multiplying the weight vector by the normalization matrix R, with the largest value selected as the optimal answer.

RESULTS AND DISCUSSION

Respondents are described through descriptive analysis into many attributes. Participant attributes in this study were divided into five categories: 1). Age, 2). Gender 3). Employment Status, 4). Income, and 5) Duration of use of the internet provider.

Table 2. Descriptive Analysis of Respondents

No.	Description	Frequency	Percentage
1.	Gender		
	Man	52	52
	Woman	48	48
2	Age		
	18 – 24	32	32
	24 – 25	35	35
	26 – 35	27	27
	36 – 40	4	4
	40 – 50	2	2
3	Employment Status		
	Private sector employee	75	75
	Civil servants	12	12
	Businessman	13	13
4	Income		
	< 3,000,000	6	6
	3,000,000 – 5,000,000	51	51
	5,000,000 – 10,000,000	37	37
	>10,000,000	6	6
5	How long to use ISP services		
	<5 years	19	19
	>5 years	81	81

Based on the table above, it can be seen that the characteristics of respondents in terms of gender include women (48%) and men (52%). The characteristics of respondents based on age are dominated by those aged 24-25 years, namely 35%, followed by 18-24 years (32%), then 26-35 years (27%), 36-40 years (4%) and finally 40-50 years (2%). In terms of employment status, respondents are still dominated by private sector employees at (75%), followed by entrepreneurs at (13%) and TNI/Polri/PNS at (12%). This is also related to the characteristics of respondents based on income which is dominated by respondents with an income of IDR 3 – 5 million (51%), followed by respondents with an income of IDR 5 – 10 million (37%), and respondents with an income of < IDR 3 million and > Rp. 10 million each amounting to (6%). Then for how long respondents have used internet service provider services, it is dominated by respondents who

have used it for more than 5 years, namely (81%), while the remainder (19%) are respondents who have used it for less than 5 years.

It can be concluded that the average user or respondent is of productive age. The average respondent has the income to use internet service provider services. In addition, respondents' profiles as users of internet service providers are an average of more than 5 years.

1. Analytical Hierarchy Process (AHP) Method

The assessment of alternative data in this study was compiled using 7 (seven) established criteria. From these criteria and alternatives, a decision hierarchy structure is designed that can facilitate the breakdown of the complexity of the problem. The AHP ISP hierarchy model can be seen in Figure 1.

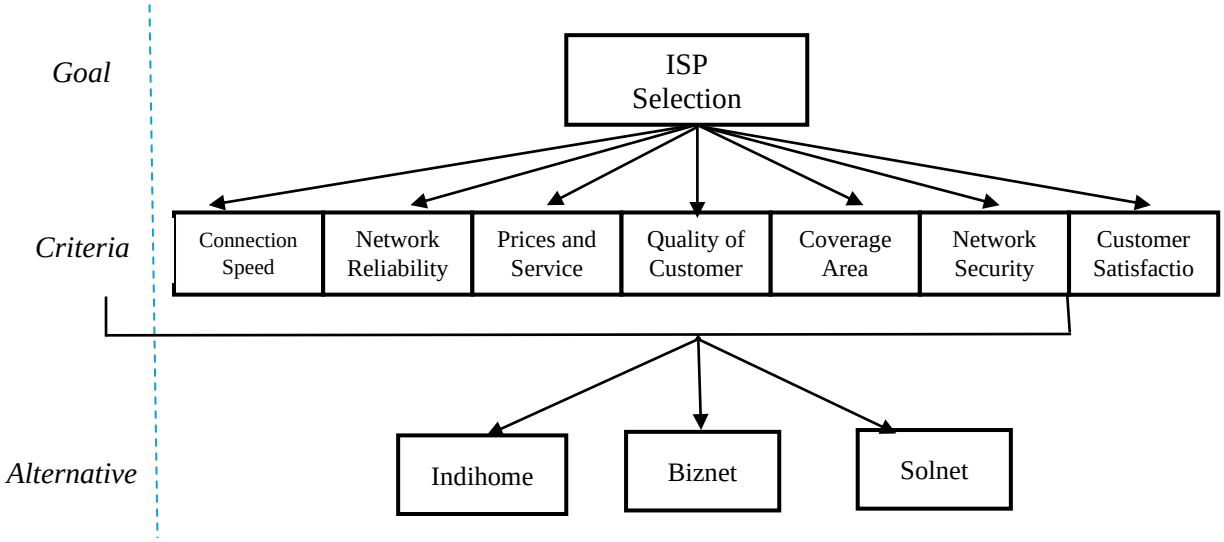

Figure 1. Hierarchical Structure

Results of the Analytic Hierarchy Process Method (AHP)

1. Comparison Value Between Criteria

Table 3. Pairwise Comparison Matrix

Criteria	A	B	C	D	E	F	G
Connection Speed (A)	1.00	2.30	3.25	2.00	2.25	0.28	0.38
Network Reliability (B)	0.43	1.00	2.25	0.39	3.52	0.25	0.40
Prices and Service Packages (C)	0.31	0.44	1.00	0.29	0.31	0.23	0.29
Customer service quality (D)	0.50	2.59	2.00	1.00	3.05	0.25	0.25
Coverage Area (E)	0.44	0.28	3.27	0.33	1.00	0.23	0.27
Network Security (F)	3.62	3.00	4.40	4.07	4.30	1.00	3.25
Customer Satisfaction (G)	2.50	2.51	3.45	3.77	3.77	0.31	1.00
Total	8.81	12.13	19.61	11.84	18.19	2.54	5.83

After constructing the hierarchy, determine priority elements by determining pairwise comparisons based on the relative importance between elements in the form of a matrix that corresponds to the pairwise comparison assessment scale. Table 3 shows the results of measuring the priority of importance of criteria in selecting ISP services. These results were obtained from geometric calculations of average data from one hundred participants. According to the comparison matrix, the best criterion from each criterion column is the value with the highest

weight for each row. A value with a weight of one is a balanced pairwise comparison. Like connection speed and network constraints, connection speed is more important than network reliability. The results are identified in the row and will get a value of 1 if it wins and a value of 0 if it loses against the column.

2. Priority Weight Calculation Between Criteria (Level 1)

Table 4 shows the comparison of assessments between criteria. Next, the value of each cell is divided by the number of values in each column to perform normalization. Calculating Priority Weight calculates the average value or weight of each criterion. If the sum of the weight values or the average of all criteria is 1, then the weight calculation is correct. The following is an example of calculating priority weight for each criterion:

$$\text{Calculation for Connection Speed – Speed } = \frac{Cell\ Value}{Column\ Total\ Value} = \frac{1}{453} = 0{,}11 \quad (5)$$

$$\text{Calculation for Connection Speed – Reliability} = \frac{Cell\ Value}{Column\ Total\ Value} = \frac{2.30}{12.13} = 0{,}19 \quad (6)$$

$$\text{Calculation of Priority Weight for Speed} = \frac{Total\ Value}{n} = \frac{0.93}{7} = 0.13 \quad (7)$$

$$\text{Calculation of Priority Weight for Reliability} = \frac{Total\ Value}{n} = \frac{0.64}{7} = 0.09 \quad (8)$$

Following this is the result of the priority weight between the criteria which will be presented in Table 4.:

Table 4. Calculation of Priority Weight between Criteria

Criteria	A	B	C	D	E	F	G	Total	Weight
Connection Speed (A)	0.11	0.19	0.17	0.17	0.12	0.11	0.06	0.93	0.13
Network Reliability (B)	0.05	0.08	0.11	0.03	0.19	0.10	0.07	0.64	0.09
Prices and Service Packages (C)	0.03	0.04	0.05	0.02	0.02	0.09	0.05	0.30	0.04
Customer service quality (D)	0.06	0.21	0.10	0.08	0.17	0.10	0.04	0.76	0.11
Coverage Area (E)	0.05	0.02	0.17	0.03	0.05	0.09	0.05	0.46	0.07
Network Security (F)	0.41	0.25	0.22	0.34	0.24	0.39	0.56	2.41	0.34
Customer Satisfaction (G)	0.28	0.21	0.18	0.32	0.21	0.12	0.17	1.48	0.21
SOR	1.00	1.00	1.00	1.00	1.00	1.00	1.00	3.00	1.00

Priority weight calculations must be normalized first, namely by dividing the value of each cell by the appropriate number of columns and then averaging each row. Based on the results of the priority weight calculation, the criteria obtained are those in the first priority, namely the network security criteria with a weight of 0.34, for the second priority, namely customer satisfaction with a weight of 0.21, then for the third priority, namely the connection speed criterion with a weight value of 0.13. The conclusion is that the priority criteria are known with the highest to lowest weights in order.

$$\lambda \max = \begin{bmatrix} 1.00 & 2.30 & 3.25 & 2.00 & 2.25 & 0.28 & 0.38 \\ 0.43 & 1.00 & 2.25 & 0.39 & 3.52 & 0.25 & 0.40 \\ 0.31 & 0.44 & 1.00 & 0.29 & 0.31 & 0.23 & 0.29 \\ 0.50 & 2.59 & 2.00 & 1.00 & 3.05 & 0.25 & 0.25 \\ 0.44 & 0.28 & 3.27 & 0.33 & 1.00 & 0.23 & 0.27 \\ 3.62 & 3.00 & 4.40 & 4.07 & 4.30 & 1.00 & 3.25 \\ 2.50 & 2.51 & 3.45 & 3.77 & 3.77 & 0.31 & 1.00 \end{bmatrix} \text{x} \begin{bmatrix} 0.13 \\ 0.09 \\ 0.04 \\ 0.11 \\ 0.06 \\ 0.35 \\ 0.22 \end{bmatrix}$$

$$\lambda \max = = 7.73$$

Calculation of Consistency Ratio and Consistency Index (CR and CI/ By dividing each element into the number of columns in question, a normalized relative weight is obtained. The eigenvector value is obtained from the average relative weight for each row.

Because the matrix is of order seven (consisting of 7 criteria), the consistency index value, which comes from a matrix of order seven, is as follows:

$$CI = \frac{\lambda max - n}{n-1} = \frac{7.73 - 7}{7-1} = 0.12 \qquad (9)$$

$$n = 7, RI = 1.32$$

$$CR = \frac{CI}{RI} = \frac{0.12}{1.32} = 0.09 \qquad (10)$$

Because CR < 0.10 indicates that the respondent's preferences are consistent with consistent testing, weighting is no longer necessary.

The calculation results shown in the table above show that network security criteria are the most important for respondents consisting of private employees, entrepreneurs, and civil servants, with a value of 0.35 or 35%. The customer satisfaction criterion is in second place with 0.22 or 22%, the network speed criterion with a value of 13%, the customer service quality criterion with a value of 0.11 or 11%, and the network reliability criterion with a value of 0.11 or 11%. Next, the coverage area criteria with a weight of 0.06 or 6%, then the price and service package criteria with a weight of 0.04 or 4%.

3. Calculation of Criteria Evaluation Factors

a. Calculation of Evaluation Factors for Speed Criteria

Table 5. Pairwise Comparison Assessment Results for Internet Speed Criteria

Alternatif	Indihome	Biznet	Solnet
Indihome	1.00	2.60	3.67
Biznet	0.38	1.00	2.50
Solnet	0.27	0.40	1.00
S.O.R	1.66	4.00	7.17

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average of the relative weights for each row.

Table 6. Pairwise Comparison Assessment Results Matrix for Normalized Internet Speed Criteria

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.60	0.65	0.51	1.66	0.59
Biznet	0.23	0.25	0.35	4.00	0.28
Solnet	0.16	0.10	0.14	7.17	0.13

The maximum eigenvalue (λ_{max}) is obtained by adding the results of multiplying the number of columns by the eigenvectors. The maximum eigenvalue that can be obtained is :

$$\lambda \max = \begin{bmatrix} 1.00 & 2.60 & 3.67 \\ 0.38 & 1.00 & 2.50 \\ 0.27 & 0.40 & 1.00 \end{bmatrix} \text{ x } \begin{bmatrix} 0.59 \\ 0.28 \\ 0.13 \end{bmatrix}$$

$$\lambda \max = = 3.05$$

Because the matrix is of order seven (consisting of 3 criteria), the consistency index values obtained are as follows:

$$CI = \frac{\lambda \max - n}{\mathrm{n} - 1} = \frac{3.05 - 3}{3 - 1} = 0.02$$

n=7, $RI = 0.58$

$$CR = \frac{CI}{RI} = \frac{0.02}{0.58} = 0.04$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation.

b. Calculation of Evaluation Factors for Network Constraints

Table 7. Pairwise Comparison Assessment Results for Internet Reliability Criteria

Alternatif	Indihome	Biznet	Solnet
Indihome	1.00	3.00	3.60
Biznet	0.33	1.00	3.05
Solnet	0.25	0.33	1.00
S.O.R	1.58	4.33	7.65

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average of the relative weights for each normalized relative row. The eigenvector value is generated from the average of the relative weights for each row.

Table 8. Pairwise Comparison Assessment Results Matrix for Normalized Network Reliability Criteria

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.63	0.71	0.40	1.56	0.58
Biznet	0.18	0.24	0.46	4.23	0.29
Solnet	0.18	0.06	0.13	7.55	0.12

The maximum eigenvalue (λ_{max}) is obtained by adding the results of multiplying the number of columns by the eigenvectors.

$$\lambda \max = \begin{bmatrix} 1.00 & 3.00 & 3.60 \\ 0.33 & 1.00 & 3.05 \\ 0.25 & 0.33 & 1.00 \end{bmatrix} \mathrm{x} \begin{bmatrix} 0.60 \\ 0.28 \\ 0.12 \end{bmatrix}$$

$\lambda \max = 3.09$

The consistency index values obtained are as follows :

$$CI = \frac{\lambda \max - n}{\mathrm{n} - 1} = \frac{3.09 - 3}{3 - 1} = 0.04$$

n=7, $RI = 0.58$

$$CR = \frac{CI}{RI} = \frac{0.04}{0.58} = 0.07$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation.

c. Calculation of Evaluation Factors for Prices and Service Packages

Table 9. Pairwise Comparison Assessment Results for Price and Service Package Criteria

Alternatives	Indihome	Biznet	Solnet
Indihome	1.00	3.00	3.05
Biznet	0.28	1.00	3.50
Solnet	0.28	0.23	1.00
S.O.R	1.56	4.23	7.55

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average of the relative weights for each normalized relative row. The eigenvector value is generated from the average of the relative weights for each row.

Table 10. Pairwise Comparison Assessment Result Matrix for Normalized Price and Package Criteria

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.64	0.71	0.40	1.56	0.60
Biznet	0.18	0.24	0.46	4.23	0.28
Solnet	0.18	0.06	0.13	7.65	0.12

The maximum eigenvalue (λ_{max}) is obtained by adding the results of multiplying the number of columns by the eigenvectors. The maximum eigenvalue that can be obtained is:

$$\lambda \max = \begin{bmatrix} 1.00 & 3.00 & 3.05 \\ 0.28 & 1.00 & 3.50 \\ 0.28 & 0.23 & 1.00 \end{bmatrix} \text{x} \begin{bmatrix} 0.58 \\ 0.29 \\ 0.12 \end{bmatrix}$$

$$\lambda \max = = 3.08$$

The consistency index values obtained are as follows :

$$CI = \frac{\lambda \max - n}{\text{n} - 1} = \frac{3.08 - 3}{3 - 1} = 0.04$$

n=7, $RI = \mathbf{0.58}$

$$CR = \frac{CI}{RI} = \frac{0.04}{0.58} = \mathbf{0.07}$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation.

d. Calculation of Evaluation Factors for Customer Service Quality

Table 11. Pairwise Comparison Assessment Result Matrix for Service Quality Criteria

Alternatives	Indihome	Biznet	Solnet
Indihome	1.00	3.25	3.50
Biznet	0.28	1.00	2.95
Solnet	0.28	0.23	1.00
S.O.R	1.56	4.48	7.45

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average

of the relative weights for each normalized relative row. The eigenvector value is generated from the average of the relative weights for each row.

Table 12. Pairwise Comparison Assessment Results Matrix for Customer Service Quality

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.64	0.72	0.47	1.56	0.61
Biznet	0.18	0.22	0.40	4.48	0.27
Solnet	0.18	0.05	0.13	7.45	0.12

The maximum eigenvalue (λmax) is obtained by adding the results of multiplying the number of columns by the eigenvectors. The maximum eigenvalue that can be obtained is:

$$\lambda \max = \begin{bmatrix} 1.00 & 3.25 & 3.50 \\ 0.28 & 1.00 & 2.95 \\ 0.28 & 0.23 & 1.00 \end{bmatrix} \text{x} \begin{bmatrix} 0.61 \\ 0.27 \\ 0.12 \end{bmatrix}$$

$$\lambda \max = = 3.06$$

The consistency index values obtained are as follows :

$$CI = \frac{\lambda \max - n}{\text{n} - 1} = \frac{3.06 - 3}{3 - 1} = 0.03$$

n=7, $RI = 0.58$

$$CR = \frac{CI}{RI} = \frac{0.03}{0.58} = 0.05$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation

e. Calculation of Evaluation Factors for Coverage Area

Table 13. Pairwise Comparison Assessment Results for Coverage Area Criteria

Alternatives	Indihome	Biznet	Solnet
Indihome	1.00	2.50	3.51
Biznet	0.23	1.00	4.82
Solnet	0.28	0.21	1.00
S.O.R	1.51	3.71	9.33

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average of the relative weights for each normalized relative row. The eigenvector value is generated from the average of the relative weights for each row

Table 14. Pairwise Comparison Assessment Result Matrix for Normalized Coverage Area Criteria

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.66	0.67	0.38	1.51	0.57
Biznet	0.15	0.27	0.52	3.71	0.31
Solnet	0.18	0.06	0.11	9.33	0.12

The maximum eigenvalue (λ_{max}) is obtained by adding the results of multiplying the number of columns by the eigenvectors. The maximum eigenvalue that can be obtained is:

$$\lambda \max = \begin{bmatrix} 1.00 & 2.50 & 3.51 \\ 0.23 & 1.00 & 4.82 \\ 0.28 & 0.21 & 1.00 \end{bmatrix} \text{x} \begin{bmatrix} 0.57 \\ 0.31 \\ 0.12 \end{bmatrix}$$

$\lambda \max = = 3.10$

The consistency index values obtained are as follows :

$$CI = \frac{\lambda \max - n}{\text{n} - 1} = \frac{3.10 - 3}{3 - 1} = 0.05$$

n=7, $RI = 0.58$

$$CR = \frac{CI}{RI} = \frac{0.05}{0.58} = 0.08$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation

f. Calculation of Evaluation Factors for Network Security

Table 15. Pairwise Comparison Assessment Results for Network Security Criteria

Alternatives	Indihome	Biznet	Solnet
Indihome	1.00	3.37	3.69
Biznet	0.30	1.00	3.05
Solnet	0.27	0.23	1.00
S.O.R	1.57	4.60	7.74

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average of the relative weights for each normalized relative row. The eigenvector value is generated from the average of the relative weights for each row.

Table 16. Pairwise Comparison Assessment Results Matrix for Normalized Network Security Criteria

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.64	0.73	0.48	1.57	0.62
Biznet	0.19	0.22	0.39	4.60	0.27
Solnet	0.17	0.05	0.13	7.74	0.12

The maximum eigenvalue (λ_{max}) is obtained by adding the results of multiplying the number of columns by the eigenvectors. The maximum eigenvalue that can be obtained is:

$$\lambda \max = \begin{bmatrix} 1.00 & 3.37 & 3.69 \\ 0.30 & 1.00 & 3.05 \\ 0.27 & 0.23 & 1.00 \end{bmatrix} \text{x} \begin{bmatrix} 0.62 \\ 0.27 \\ 0.12 \end{bmatrix}$$

$\lambda \max = = 3.10$

The consistency index values obtained are as follows:

$$CI = \frac{\lambda \max - n}{\text{n} - 1} = \frac{3.10 - 3}{3 - 1} = 0.05$$

n=7, $RI = 0.58$

$$CR = \frac{CI}{RI} = \frac{0.05}{0.58} = 0.08$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation.

g. Calculation of Evaluation Factors for Customer Satisfaction

Table 17. Paired Comparison Assessment Results for Customer Satisfaction Criteria

Alternatives	Indihome	Biznet	Solnet
Indihome	1.00	3.30	2.60
Biznet	0.27	1.00	3.25
Solnet	0.29	0.21	1.00
S.O.R	1.56	4.51	6.85

The elements in each column are divided by the number of columns concerned, and the normalized relative weights are obtained. The eigenvector values are generated from the average of the relative weights for each normalized relative row. The eigenvector value is generated from the average of the relative weights for each row.

Table 18. Pairwise Comparison Assessment Results Matrix for Customer Satisfaction Criteria

Alternatives	Indihome	Biznet	Solnet	Total	Eigen
Indihome	0.64	0.73	0.38	1.56	0.58
Biznet	0.17	0.22	0.47	4.51	0.29
Solnet	0.19	0.05	0.15	6.85	0.13

The maximum eigenvalue (λ_{max}) is obtained by adding the results of multiplying the number of columns by the eigenvectors. The maximum eigenvalue that can be obtained is:

$$\lambda \max = \begin{bmatrix} 1.00 & 3.30 & 2.60 \\ 0.27 & 1.00 & 3.25 \\ 0.29 & 0.21 & 1.00 \end{bmatrix} \text{x} \begin{bmatrix} 0.60 \\ 0.28 \\ 0.12 \end{bmatrix}$$

$$\lambda \max = 3.08$$

The consistency index values obtained are as follows:

$$CI = \frac{\lambda \max - n}{\text{n} - 1} = \frac{3.08 - 3}{3 - 1} = 0.04$$

Untuk n=7, $RI = \mathbf{0.58}$

$$CR = \frac{CI}{RI} = \frac{0.04}{0.58} = \mathbf{0.07}$$

Because CR < 0.10 means that the respondent's preference is consistent. With consistent testing, weighting is no longer required for recalculation.

4. Total Ranking Alternative Calculation (Provider)

Table 19. Total Ranking

Provider	Criteria	Weight	Ranking		%
			Alternative	Criteria	
Indihome	Connection Speed (A)	0.59	4	Ranking 1	**60%**
	Network Reliability (B)	0.60	3		
	Prices and Service Packages (C)	0.58	5		
	Customer service quality (D)	0.61	2		
	Coverage Area (E)	0.57	7		

Provider	Criteria	Weight	Ranking		%
			Alternative	Criteria	
	Network Security (F)	0.62	1		
	Customer Satisfaction (G)	0.58	6		
Biznet	Connection Speed (A)	0.28	4	Ranking 2	**28%**
	Network Reliability (B)	0.28	5		
	Prices and Service Packages (C)	0.29	3		
	Customer service quality (D)	0.27	6		
	Coverage Area (E)	0.31	1		
	Network Security (F)	0.27	7		
	Customer Satisfaction (G)	0.29	2		
Solnet	Connection Speed (A)	0.13	1	Ranking 3	**12%**
	Network Reliability (B)	0.12	7		
	Prices and Service Packages (C)	0.12	6		
	Customer service quality (D)	0.12	5		
	Coverage Area (E)	0.12	4		
	Network Security (F)	0.12	3		
	Customer Satisfaction (G)	0.13	2		

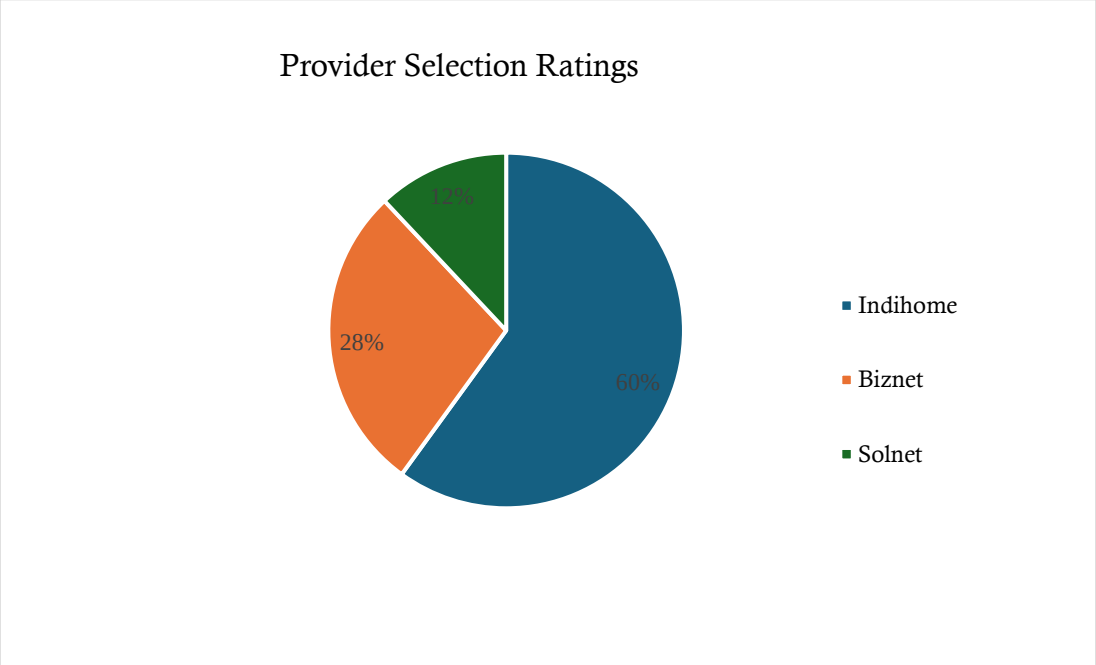

Figure 2. Provider Selection Ratings

The results of the study using the AHP method showed that the best internet service is Indihome with a score of 0.60 or 60% on all criteria.

Results of the Simple Additive Weighting Method (SAW)

The SAW method does not offer pairwise comparisons for calculating weights, an approach similar to the AHP method is used to calculate priority weights for each criterion and sub-criteria and calculate evaluation factors for each alternative. The SAW method is used to search for alternative rankings, where priority weights and evaluation factors have been obtained from calculations using the previous AHP method. The resulting criterion weight values can be used for subsequent calculations with the SAW method (Diana, 2022)

1. Calculation for All Criteria

Determination of the weight of each sub-criteria in the criteria is described in Table 20

Table 20. Matrix of Relationship between Criteria and Weight

Criteria	Criteria Weight	Category
Connection Speed (A)	0.13	Benefit
Network Reliability (B)	0.09	Benefit
Prices and Service Packages (C)	0.04	Benefit
Customer service quality (D)	0.11	Benefit
Coverage Area (E)	0.07	Benefit
Network Security (F)	0.34	Benefit
Customer Satisfaction (G)	0.21	Benefit

The determination of the weight of these criteria is based on the results of research using the AHP method, which is adjusted to the level of need for each criterion in selecting an internet service provider

2. Rating Calculation

Table 21. Relationship Matrix between Criteria and Weight

Providers	Criteria						
Alternative	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Indihome	3.67	3.60	3.05	3.50	3.51	3.69	2.60
Biznet	2.60	3.00	3.00	3.25	2.50	3.37	3.30
Solnet	2.50	3.05	3.50	2.95	4.82	3.05	3.25
Max	**3.67**	**3.60**	**3.50**	**3.50**	**4.82**	**3.69**	**3.30**

Table 21 shows the determination of the suitability rating of each alternative for each criterion.

3. Normalization of Decision Test Matrix

Matrix normalization is based on the type of criteria that has been adjusted to the type of benefit or cost criteria so that a normalized matrix can be obtained. The results of the normalization matrix (R) of each alternative value are as follows:

Table 22. Normalized Criteria Relationship Matrix

Providers	Criteria						
Alternative	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Indihome	1.00	1.00	0.87	1.00	0.73	1.00	0.79
Biznet	0.71	0.83	0.86	0.93	0.52	0.91	1.00
Solnet	0.68	0.85	1.00	0.84	1.00	0.83	0.98
bobot	0.13	0.09	0.04	0.11	0.07	0.34	0.21

4. Ranking

The following is the process of calculating the preference value (Vi) for each choice by multiplying the normalized matrix (R) by the weight vector (W). To obtain a ranking, the criteria weights (W), normalized results (R), and total results for each alternative are multiplied in a matrix. The best choice is the one with the highest overall value.

W = (0.4|0.1|0.1|0.2|0.2) matrix
V1 = 0.92
V2 = 0.86
V3 = 0.86

Based on the findings of these calculations, it can be determined that option V1, which has a value of 0.2—the maximum value that a featured provider can have—has the highest preference value when choosing an internet provider.

Table 23. Total Ranking

Alternative (Provider)	Weights	Ranking	Percentage
V1 (Indihome)	0.92	I	92%
V2 (Biznet)	0.86	II	86%
V3 (Solnet)	0.86	III	86%

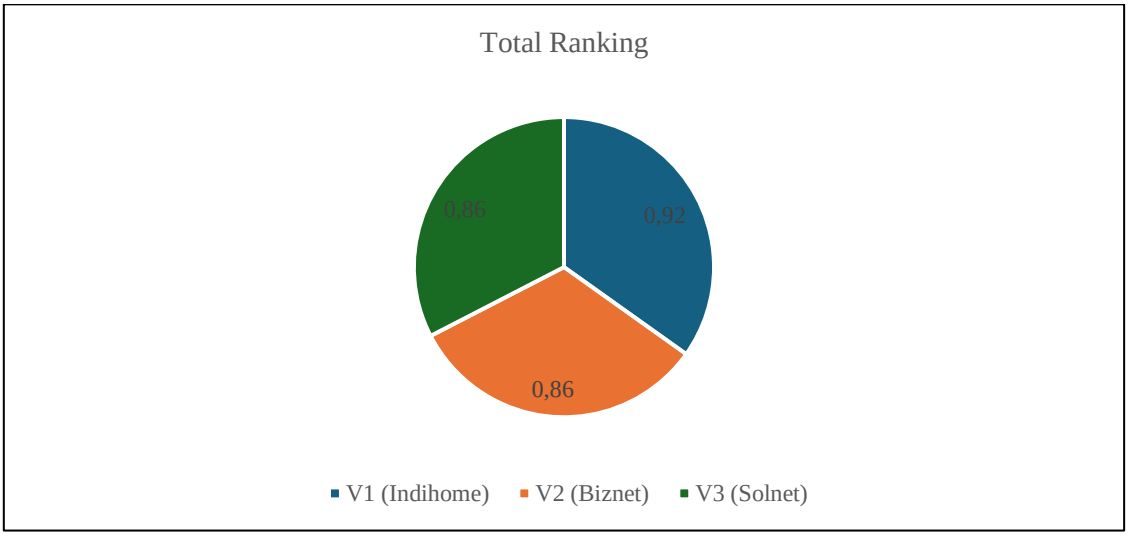

Figure 3. Total Ranking SAW method

Research using the SAW method has 7 indicator parameters that are used as a reference to determine which internet service provider will be ranked first. The results of the calculations carried out by the SAW method for Internet Service Providers are Indihome which is ranked first among other ISPs. In other words, Indihome has the highest and best overall value in the SAW method. While the second position is occupied by Biznet and the last is Solnet

Comparison of Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) Results

The ranking results of the SAW technique and the AHP method show several similarities based on the simulations used to evaluate both approaches

Table 24. Comparison of AHP and SAW Methods

No	Provider	AHP	SAW
1	Indihome	0.60	0.92
2	Biznet	0.28	0.86
3	Solnet	0.12	0.86

The results of research on the comparison of SAW and AHP methods in decision-making to determine the best provider, it can be concluded that the calculation results of SAW and AHP methods have the same ranking. The difference in the percentage value of the best provider

choice according to the results of the AHP method of 60% is Indihome and the SAW method is 92% Indihome. It can be concluded that both methods provide recommendations that Indihome is the best choice of internet service provider (ISP). Provider Indihome menjadi provider internet peringkat pertama yang paling banyak dipilih (Briantama, 2021)

Based on the results of research comparing the SAW and AHP methods in making decisions to determine the best provider, it can be concluded that the calculation results of the SAW and AHP methods have the same ranking. The two alternatives with the greatest value are the selected providers. The three best providers according to the AHP and SAW methods are Indihome with weights of 60% and 92%, respectively.

Based on these findings, it can be said that the SAW approach only considers factors in choosing the best service. A measurement scale and a way to obtain priorities (weights) for the entire hierarchy of criteria and alternatives (providers) must also be provided with the AHP technique in order to identify the best provider. This is done by grouping criteria and alternatives (providers) and carrying out pairwise comparisons.

The consistency ratio (CR) of the AHP technique for calculating weights is related to the criteria weights. Weights should not be used if the value is more than 0.1 because it indicates that the criteria weights are inconsistent. Meanwhile, determining the weights of the SAW approach only takes into account the weights of the criteria that need to be normalized, or if combined the result is equal to 1. Therefore, using the AHP technique in choosing an internet service provider is more successful because it allows you to learn what factors, such as security and network speed, users prioritize when choosing an ISP.

The AHP method is considered an appropriate representation that tends to group system elements into several levels, each level contains similar elements and also provides a measurement scale and method for obtaining priorities. (Lestari, 2023)

Selection of Internet Service Provider using the AHP Method

Based on the results of data processing using the AHP method, network security criteria are the most important criteria for respondents consisting of private employees, entrepreneurs, and civil servants with a weight of 0.35 or 35%, next is customer satisfaction with a weight of 0.22 or 22%, network speed criteria with a weight of 13%, customer service quality criteria with a weight of 0.11 or 11%, network reliability criteria with a weight of 0.11 or 11%, then coverage area criteria with a weight of 0.06 or 6%, then price and service package criteria with a weight of 0.04 or 4%. This is in line with research from Kurniawan et al. (2024) which states that network security must be considered considering the increasing number of internet users to protect them from careless parties. The use of the AHP method is the ranking of each alternative, namely the most important alternative obtained and widely used by consumers is the internet provider in terms of security criteria. (Nurajizah, 2020)

For the alternative (provider), 100 respondents chose Indihome as the best provider. Following AHP weights, the final result of determining the best internet service provider used by the community is Indihome, with a value of 0.60 or 60% for all criteria. The ranking obtained from the calculation of the AHP method testing obtained alternative results in the form of determining the Indihome Internet Provider which is the most ideal for use on wireless networks in the home area environment. (Siregar, 2021). The order of the 3 main criteria priorities in selecting internet services. Selection of the right internet service using the four best choices, namely Indihome (Aritonang, 2023).

Selection of Internet Service Providers Using the SAW Method

Based on the results of questionnaire calculations carried out on one hundred participants using the SAW method, it was found that alternative V1 had the highest preference value for choosing an internet provider, with a value of 92% which is the highest value for a superior internet provider. In line with research (Zabar & Novianto, 2015) which states that the research results show that the consistency ratio value of 0.0794 is lower than the consistency ratio value

used, which shows that the calculation results are valid and can be used. The results of this application support the decision that IndiHome is the best wireless provider for use in the home area. In line with this research, the SAW method is suitable for use in decision support systems by considering the selected criteria. These criteria include network speed, Connection, Cost, and Number of Users. (Gunawan, 2023)

The application of the Simple Additive Weighting (SAW) Method in the Decision Support System in Selecting Internet Service Packages produces a system that can provide recommendations for internet packages that are by customer needs and make it easier for users to run the decision support system for selecting internet service packages. The application of the Simple Additive Weighting (SAW) method was successfully carried out in this study by producing a recommended provider ranking. (Sopian, 2021)

Comparison from the Analytical Hierarchy Process (AHP) Method with the Simple Additive Weighting (SAW) Method

Based on the comparison that has been carried out, it can be seen that the two AHP methods and SAW, produce the same ranking in determining the selection of the best provider. The comparison table shows that Indihome has the highest score with a weight of 60% in the AHP method and 92% in the SAW method. SAW method to rank alternatives. (Mashal, 2020)

In this study, the SAW method only weights criteria, while the AHP method requires grouping criteria and alternatives and carrying out pairwise comparisons to get priorities. The AHP method also takes into account the consistency ratio (CR) in determining the criteria weight. If the CR is more than 0.1, then the criteria weight is inconsistent and cannot be used. In contrast, the SAW method only requires normalized criteria weights with the sum result equal to 1. Thus, AHP is more effective in selecting internet service providers because it can determine the criteria prioritized by customers, such as security and network speed.

CONCLUSION

The results of using the Analytical Hierarchy Process (AHP) method show that the most important criteria according to respondents is network security with a weight of 0.35 or 35%, next is customer satisfaction with a weight of 0.22 or 22%, network speed criteria with a weight of 13%, service quality criteria customers with a weight of 0.11 or 11%, network reliability criteria with a weight of 0.11 or 11%, then coverage area criteria with a weight of 0.06 or 6%, then price and service package criteria with a weight of 0.04 or 4%. For alternatives (Provider), Indihome has the superior value, namely 60%, followed by Biznet and Solnet with values of 28% and 12% respectively. The results of using the Simple Additive Weighting (SAW) method show that the highest preference value for selecting an Internet Service Provider is alternative V1 (IndiHome) with a value of 92%, which is the maximum value where there is a superior Internet Service Provider. V2 (Biznet) with a score of 86% and V3 (Solnet) with a score of 86%. From the results of the comparison of the AHP and SAW methods in selecting an Internet Service Provider, it is known that the AHP method is more appropriate to use for making selection decisions. In addition, AHP provides a measurement scale and an effective method for obtaining hierarchical priority criteria.

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