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Combination of CRITIC Weighting Method and Multi-Attribute Utility Theory in Network Vendor Selection

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Abstract−The main problems in the selection of network vendors include uncertainty regarding the credibility and reliability of the vendor, which can result in the risk of product or service failure. Choosing a network vendor requires a thorough evaluation of the vendor's credibility and track record to ensure their reliability and experience in the industry. In addition, the technology compatibility and flexibility of the product need to be checked to ensure seamless integration with existing infrastructure and the ability to adapt to evolving needs. The combination of the CRITIC weighting and MAUT methods can result in a robust and holistic approach in the decision support system. CRITIC is used to determine the relative weight of each criterion based on the correlation analysis between the criteria, thus helping to reduce subjectivity and improve the objectivity of the assessment. Once the criterion weights are set using CRITIC, MAUT can be used to calculate the utility score of each alternative based on the weights of that criterion. MAUT allows the integration of decision-maker subjective preferences into the analysis, thus allowing for a more thorough and accurate evaluation of the alternatives being evaluated. The results of the network vendor ranking show that Nusanet gets the first rank with a final score of 0.6214, Zitline gets the second rank with a final score of 0.5317, MMS gets the third rank with a final score of 0.5276, TMS gets the fourth rank with a final score of 0.4147, and JPDN gets the fifth rank with a final score of 0.3677. This combination of the CRITIC and MAUT methods provides a comprehensive approach to network vendor selection, ensuring that decisions are based on structured, transparent, and measurable analysis, resulting in the most optimal vendor selection for the organization's needs.

Keywords: Combination; CRITIC Weighting; Decision; MAUT Method; Selection

1. INTRODUCTION

A network vendor is a company or service provider that provides essential hardware, software, and network infrastructure solutions for operations and communications within an organization. They offer a wide range of products such as routers, switches, firewalls, and wireless devices, as well as services such as installation, configuration, maintenance, and technical support. Choosing the right network vendor is essential to ensure a reliable, secure, and scalable network infrastructure. A good vendor not only provides high-quality products but also offers superior after-sales service, technical support, and a commitment to technological innovation. In the network vendor selection process, it is important for organizations to evaluate the vendor's credibility and reputation, ensuring they have solid experience and track record in the industry. Additionally, advanced security features and compliance with industry standards are key factors for protecting data and networks from cyber threats. Key issues in network vendor selection include uncertainty about vendor credibility and reliability, which can result in the risk of product or service failure. Choosing a network vendor requires a thorough evaluation of the vendor's credibility and track record to ensure their reliability and experience in the industry. Additionally, the technology compatibility and flexibility of the product need to be checked to ensure seamless integration with existing infrastructure and the ability to adapt to evolving needs. Network vendors have a critical role to play in providing hardware, software, and services that support business operations and sustainability. Therefore, optimal vendor selection requires a systematic and objective approach. The combination of CRITIC and MAUT helps reduce subjectivity in criterion assessments, resulting in more objective and accurate weighting. The research contributes to the scientific literature by offering a new hybrid model in network vendor selection, which can be adopted and adapted for a variety of other industry contexts. By combining CRITIC and MAUT, this research is expected to provide better and systematic solutions in the decision-making process, which in turn will support the company's operational success in the long term.

Network vendor selection using a Decision Support System (DSS) is a structured and data-driven approach to selecting vendors that best suit the needs of the organization. By using DSS, organizations can make more objective and informed decisions[1]–[3], ensuring that the selected vendor is able to meet their operational and strategic needs. Multi-Attribute Utility Theory (MAUT) is a method in decision support systems used to evaluate and choose between various alternatives based on several criteria. MAUT takes into account the preferences of decision-makers in a systematic and quantitative way[4]–[7], allowing for a more precise and consistent assessment of available options. The main advantage of the MAUT method is its ability to integrate the subjective preferences of decision-makers into a systematic and structured evaluation process. MAUT allows decision-makers to identify and assess various important criteria separately, then combine those preferences in a mathematical model that generates a score or rating for each alternative. This approach helps to reduce subjective perceptions and improve consistency in decision-making, as well as allow for more complex modeling by considering trade-offs between different criteria. One of the main drawbacks in determining the weight of criteria using the MAUT method is the subjectivity that may occur in the process[8], [9]. The weighting of criteria often depends on the preferences and subjective views of the decision-makers or teams involved in the analysis. This can result in differences in assessment between individuals or groups, which in turn can affect the final outcome of the evaluation process.

Criteria Importance Through Intercriteria Correlation (CRITIC) is a method used in decision support systems to assess the importance of each criterion based on the correlation between these criteria[10]–[12]. This method recognizes that interrelated or highly correlated criteria tend to have a similar impact on the final decision. The CRITIC method calculates a correlation matrix between all criteria pairs to determine the extent to which one criterion affects the other criteria in the specific context being evaluated. In this way, decision-makers can set the weight of the criteria more objectively based on the relative impact of each criterion on the final decision. The CRITIC method provides an analytical structure that helps reduce subjectivity in the weighting of criteria and improve consistency in alternative evaluation processes in the context of decision support systems. The main advantage of the CRITIC method is its ability to overcome some of the challenges that commonly occur in setting criteria weights in decision support systems. First, this method uses a more objective approach by analyzing the correlation between the criteria, thereby reducing the level of subjectivity in determining the weight. This correlation analysis helps identify criteria that are interrelated or have a similar impact on the final decision, so that the weight of the criteria can be more accurately established based on their interactions. The CRITIC method provides a systematic and structured framework for understanding and measuring the relative impact of each criterion, allowing decision-makers to make more informed and measurable decisions. The CRITIC method not only improves the quality of decisions but also increases transparency and consistency in the alternative evaluation process.

The combination of the CRITIC and MAUT weighting methods can result in a robust and holistic approach in the decision support system. CRITIC is used to determine the relative weight of each criterion based on the analysis of correlations between criteria, which helps to reduce subjectivity and increase objectivity in assessment. Once the criterion weights are set using CRITIC, MAUT can be used to calculate the utility score of each alternative based on the weights of that criterion. MAUT allows the integration of subjective preferences of decision-makers into the analysis, thus allowing for a more thorough and accurate evaluation of the alternatives being evaluated. With this combination, decision-makers can make more informed and reasoned decisions, taking into account both objective aspects (based on correlation analysis) and subjective preferences (based on utility). This allows decision support systems to be more effective in supporting complex and important decision-making processes in various organizational or project contexts. The combination of CRITIC and MAUT also provides a clear and structured framework for the decision-making process, facilitating the interpretation of results and communication between decision-making teams. By using this approach, organizations can optimize their decision-making processes, improve the quality of decisions, and reduce the risk of errors or biases that may arise in traditional analysis. The combination of the CRITIC and MAUT methods is a powerful tool to increase efficiency and effectiveness in facing complex and important decision-making challenges.

Research related to vendor selection was conducted by [13] using the AHP method to help companies in making decisions, especially in the selection of project vendors with the result that Vendor B ranks first with a weight of 0.35. The research conducted by [14] the vendor selection process is generally carried out with a subjective approach based on the experience of parties who view the company as competent in vendor selection matters. The SAW method is used in the selection of vendors to obtain objective assessment results based on good performance standards and in accordance with the criteria. Research conducted by the [15] WASPAS (Weighted Aggregated Sum Product Assessment) method is used to determine the best choice through weighted addition and multiplication and will produce vendors that suit their needs and preferences. Research conducted by the [16] Weight Product (WP) method in selecting IT vendors for corporate projects has become an effective and efficient tool in helping companies choose the most suitable IT vendor for their projects. The research conducted by [17] a combination of Fuzzy AHP and TOPSIS will be used in vendor selection, alternative ranking based on established criteria that have been calculated using the Fuzzy AHP method. The difference with the research conducted is that in this study the CRITIC weighting method is applied which will produce weights objectively based on the assessment data carried out on existing alternatives.

The purpose of this study is to develop an integrated and holistic approach in the selection of network vendors by combining the advantages of the CRITIC method in determining the weight of the criteria and MAUT in evaluating the relative utility of each vendor alternative. This aims to improve objectivity, accuracy, and quality of decisions in choosing a network vendor that best suits the organization's needs.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research stage is a systematic process that involves important steps to generate new knowledge or validate existing knowledge[18]–[20]. This stage begins with the identification of relevant research problems, followed by the formulation of hypotheses or research questions to be answered. After that, data collection is carried out and then analyzed using statistical techniques or qualitative analysis according to the nature of the data and research objectives.

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The results of the analysis are used to draw conclusions and compile research reports that describe the findings and their implications for the field of knowledge concerned. A good stage of research ensures that the process from start to finish is carried out carefully and methodically to ensure the validity and reliability of the findings obtained. Figure 1 is the framework of the research conducted.

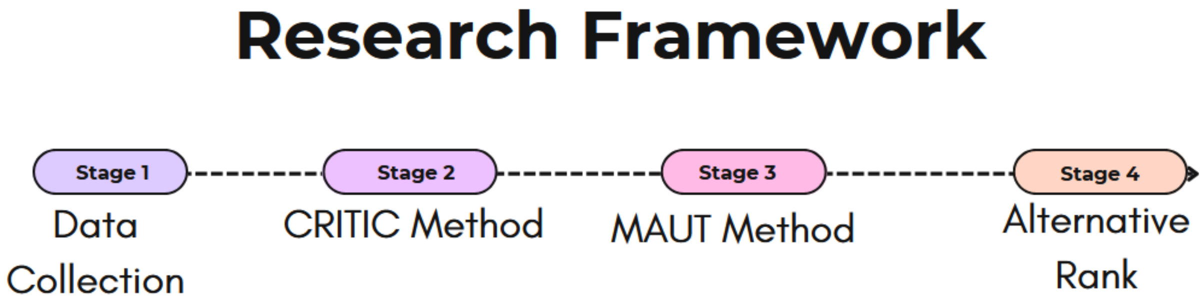

Figure 1. The Research Framework

The research framework of figure 1 is a process carried out to achieve the objectives of the research carried out starting from data collection, applying the CRITIC weighting method, applying the MAUT method which will produce alternative rankings. A rigorous and comprehensive research framework is essential to ensure that the knowledge produced has high value and relevance for the scientific community and the general public.

2.2 Stage 1: Data Collection

Data collection is one of the key stages in the research process which is carried out to collect the information needed to answer research questions or test hypotheses that have been formulated. In selecting a network vendor, there are several key factors to consider to ensure the success of the network's implementation and operations. The criteria used in selecting a network vendor are price, experience, reliability and performance, security features, assurance, and communication. By considering these factors holistically, companies can make informed decisions in choosing a network vendor that suits their business needs.

2.3 Stage 2: CRITIC Method

The CRITIC weighting method is one of the methods used in the analysis of multi-criteria decisions to determine the weight or importance of each criterion. This method considers the relationship between existing criteria by measuring the degree of correlation between one criterion and another. Creating a decision matrix is the first step in the CRITIC method, the value of each alternative for each criterion will be created in the form of columns and updates. The decision matrix is made using equation (1).

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \tag{1}$$

Calculating the matrix normalization value is the second stage in the CRITIC method, each alternative will calculate the matrix normalization value for each criterion. The normalization value of the matrix is calculated using equation (2).

$$d_{ij} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{2}$$

Calculating the value of the quantity of information from each criterion is the third stage in the CRITIC method. The value of the quantity of information from each criterion is calculated using equation (3).

$$C_j = \sigma_j \sum_{j=1}^{n} \left(1 - R_{ij}\right) \tag{3}$$

Where the standard deviation value is calculated using equation (4).

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{n} \left(d_{ij} - \bar{d}_j\right)^2}{n}} \tag{4}$$

Where the correlation coefficienct value is calculated using equation (5).

$$R_{ij} = \frac{\sum_{i=1}^{n} (d_{ij} - \bar{d}_j) * (d_{ij} - \bar{d}_h)}{\sqrt{\sum_{i=1}^{n} \left(d_{ij} - \bar{d}_j\right)^2} * \sqrt{\sum_{i=1}^{n} \left(d_{ij} - \bar{d}_h\right)^2}} \tag{5}$$

Calculating the final weight value of each criterion is the last stage in the CRITIC method. The final weight value of each criterion is calculated using equation (6).

$$W_j = \frac{C_j}{\sum C_j} \tag{6}$$

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The final weights generated from the CRITIC method reflect the relative significance of each criterion in the multi-criteria analysis, taking into account the variation of the data and the correlation between the criteria.

2.4 Stage 3: MAUT Method

The MAUT method is a decision analysis approach used to choose between several alternatives that have various attributes or criteria that must be considered. This method combines elements of utility theory with multi-criteria decision-making, where each criterion is weighted based on its importance relative to the decision-maker's goals or preferences. Normalization is the first stage in the MAUT method, each alternative is evaluated against each criterion that has been set. This evaluation often involves measuring or calculating data normalization so that it produces values in the same range, normalization is calculated using equation (7) and (8).

$$r_{ij}^* = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (7)$$

$$r_{ij}^* = 1 + \frac{\min x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (8)$$

The calculation of the normalized value of equation (1) is to calculate the criteria that have the type of benefit, while equation (2) is to calculate the criteria that have the type of cost.
Calculating the utility value is the second stage in the MAUT method, each alternative will be calculated the utility value for each criterion. The utility value is calculated using equation (9).

$$u_{ij} = \frac{e^{\left(\left(r_{ij}^*\right)^2\right)} - 1}{1.71} \quad (9)$$

Calculating the final value of the utility is the last stage in the MAUT method, each alternative will be calculated the final value of the utility for the entire criterion. The final value of the utility is calculated using equation (10).

$$u_{(x)} = \sum_{j=1}^{n} w_j * u_{ij} \quad (10)$$

The alternative that has the highest utility value is the best choice based on the decision-maker's preferences and goals. This process allows decision-makers to choose the alternative that best suits their preferences objectively, taking into account all relevant criteria.

2.5 Stage 4: Alternative Rank

Alternative ranking of network vendor selection can be done based on several key criteria that are relevant to the company's needs and priorities. By conducting a holistic evaluation based on these criteria, companies can create a structured and in-depth ranking to select the network vendor that best suits their needs.

3. RESULT AND DISCUSSION

The combination of the CRITIC weighting and MAUT methods offers a holistic and objective approach to network vendor selection. The CRITIC method is used to objectively determine the weight of the criteria based on data variation and correlation between criteria, while MAUT translates the value of the criteria into a utility score that reflects the preferences of the decision makers. By combining the criteria weights from CRITIC and the utility score from MAUT, the vendor selection process becomes more transparent, consistent, and supported by robust data analysis, resulting in more informed and accountable decisions. The combination of the CRITIC and MAUT methods in the selection of network vendors offers several significant advantages. First, this approach ensures objectivity in determining the weighting of criteria through statistical analysis, reducing subjective bias. Second, MAUT provides a clear framework for converting criterion values into easy-to-compare utility scores, taking into account decision-makers' preferences and priorities. Third, by using these two methods, the vendor selection process becomes more comprehensive and transparent, allows for more precise and data-backed decisions, and increases trust and accountability in the vendor selection process.

3.1 Data Collection

Data collection in the selection of network vendors is a crucial stage that involves the collection of quantitative and qualitative information about various relevant aspects of each vendor. This data includes criteria such as are price, experience, reliability and performance, security features, assurance, and communication. Data collection is done through various sources such as vendor proposals, customer surveys, performance reports, and live interviews. The quality of the data collected is crucial, as accurate and complete data allows for objective and comprehensive evaluation. This process ensures that all factors influencing the selection decision are thoroughly considered, thus helping decision-makers choose the vendor that best suits the needs and expectations of the organization. Table 1 is the assessment data on the selection of network vendors.

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Table 1. Assessment Data on the Selection of Network Vendors

Vendor Name	Price	Experience	Reliability and Performance	Security Features	Assurance	Communication
Nusanet	4	5	4	3	4	5
MMS	3	4	4	5	4	4
Zitline	5	5	5	4	3	5
JPDN	4	4	4	4	4	4
TMS	4	5	5	4	3	4

The assessment data in table 1 is obtained based on the assessment of companies that receive bid proposals from existing network vendors, this data will be used in the selection of network vendors.

3.2 CRITIC Method for Determining the Weight of Criteria

The CRITIC method is a technique used to objectively determine the weight of criteria in a multi-criteria analysis. This method considers data variation and correlation between criteria to generate weights that reflect the importance of each criterion in decision-making. Creating a decision matrix is the first step in the CRITIC method, the value of each alternative for each criterion will be created in the form of columns and updates. The decision matrix is made using equation (1).

$$X = \begin{bmatrix} 4 & 5 & 4 & 3 & 4 & 5 \\ 3 & 4 & 4 & 5 & 4 & 4 \\ 5 & 5 & 5 & 4 & 3 & 5 \\ 4 & 4 & 4 & 4 & 4 & 4 \\ 4 & 5 & 5 & 4 & 3 & 4 \end{bmatrix}$$

Calculating the matrix normalization value is the second stage in the CRITIC method, each alternative will calculate the matrix normalization value for each criterion. The normalization value of the matrix is calculated using equation (2).

$$d_{11} = \frac{x_{11} - \min x_{11;15}}{\max x_{11;15} - \min x_{11;15}} = \frac{4-3}{5-4} = 0.5$$

Table 2 is the result of the overall normalization calculation of the CRITIC weighting method.

Table 2. The Results of the Overall Normalization Calculation of the CRITIC Weighting Method.

Vendor Name	Price	Experience	Reliability and Performance	Security Features	Assurance	Communication
Nusanet	0.5	1	0	0	1	1
MMS	0	0	0	1	1	0
Zitline	1	1	1	0.5	0	1
JPDN	0.5	0	0	0.5	1	0
TMS	0.5	1	1	0.5	0	0

Table 2 is the result of the value calculation of the matrix normalization of each alternative to the existing criteria using the CRITIC method.

Calculating the value of the quantity of information from each criterion is the third stage in the CRITIC method. Before calculating the value of the quantity of information from each criterion, the standard deviation value of each criterion will be calculated using equation (4).

$$\sigma_1 = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{11;15} - \bar{d}_{11;15}\right)^2}{5}} = 0.3162$$

$$\sigma_2 = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{21;25} - \bar{d}_{21;25}\right)^2}{5}} = 0.4899$$

$$\sigma_3 = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{31;35} - \bar{d}_{31;35}\right)^2}{5}} = 0.4899$$

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$$\sigma_4 = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{41;45} - \bar{d}_{41;45}\right)^2}{5}} = 2.0248$$

$$\sigma_5 = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{51;55} - \bar{d}_{51;55}\right)^2}{5}} = 0.4899$$

$$\sigma_6 = \sqrt{\frac{\sum_{i=1}^{n}\left(d_{61;65} - \bar{d}_{61;65}\right)^2}{5}} = 0.4899$$

Next, calculate the coefficient correlation value of each criterion using equation (5), table 3 is the result of the calculation of the coefficient correlation value.

Table 3. The Results of the Calculation of the Coefficient Correlation Value.

	Price	Experience	Reliability and Performance	Security Features	Assurance	Communication
Price	0	0.3545	0.3545	1.5	1.6455	0.354502776
Experience	0.355	0	0.3333	1.6455	1.6667	0.333333333
Reliability and Performance	0.355	0.3333	0	1	2	0.833333333
Security Features	1.5	1.6455	1	0	1	1.645497224
Assurance	1.645	1.6667	2	1	0	1.166666667
Communication	0.355	0.3333	0.8333	1.6455	1.1667	0

Table 3 is the result of the calculation of the coefficient correlation value of each criterion using the CRITIC method. Calculating the value of the coefficient of each criterion is the fourth stage in the CRITIC method. The value of the coefficient of each criterion is calculated using equation (6).

$$Q_1 = \sigma_1 \sum_{j=1}^{n}\left(1 - R_{11;15}\right) = 0.3162 * 4.2090 = 1.331$$

$$Q_2 = \sigma_2 \sum_{j=1}^{n}\left(1 - R_{21;25}\right) = 0.4899 * 4.3333 = 2.1229$$

$$Q_3 = \sigma_3 \sum_{j=1}^{n}\left(1 - R_{31;35}\right) = 0.4899 * 4.5212 = 2.2149$$

$$Q_4 = \sigma_4 \sum_{j=1}^{n}\left(1 - R_{41;45}\right) = 0.3162 * 6.791 = 2.1475$$

$$Q_5 = \sigma_5 \sum_{j=1}^{n}\left(1 - R_{51;55}\right) = 0.4899 * 7.4788 = 3.6639$$

$$Q_6 = \sigma_6 \sum_{j=1}^{n}\left(1 - R_{61;65}\right) = 0.4899 * 4.3333 = 2.1229$$

Calculating the final weight value of each criterion is the last stage in the CRITIC method. The final weight value of each criterion is calculated using equation (7).

$$W_1 = \frac{C_1}{\sum C_{1;6}} = \frac{1.331}{1.331 + 2.1229 + 2.2149 + 2.1475 + 3.6639 + 2.1229} = \frac{1.331}{13.6031} = 0.0978$$

$$W_2 = \frac{C_2}{\sum C_{1;6}} = \frac{2.1229}{1.331 + 2.1229 + 2.2149 + 2.1475 + 3.6639 + 2.1229} = \frac{1.331}{13.6031} = 0.1561$$

$$W_3 = \frac{C_3}{\sum C_{1;6}} = \frac{2.2149}{1.331 + 2.1229 + 2.2149 + 2.1475 + 3.6639 + 2.1229} = \frac{1.331}{13.6031} = 0.1628$$

$$W_4 = \frac{C_4}{\sum C_{1;6}} = \frac{2.1475}{1.331 + 2.1229 + 2.2149 + 2.1475 + 3.6639 + 2.1229} = \frac{1.331}{13.6031} = 0.1579$$

$$W_5 = \frac{C_5}{\sum C_{1;6}} = \frac{3.6639}{1.331 + 2.1229 + 2.2149 + 2.1475 + 3.6639 + 2.1229} = \frac{1.331}{13.6031} = 0.2693$$

$$W_6 = \frac{C_6}{\sum C_{1;6}} = \frac{2.1229}{1.331 + 2.1229 + 2.2149 + 2.1475 + 3.6639 + 2.1229} = \frac{1.331}{13.6031} = 0.1561$$

The results of the weight value using the CRITIC method will be applied in the MAUT method to select network vendors.

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3.3 MAUT Method in Network Vendor Selection

The Multi-Attribute Utility Theory (MAUT) method is one of the effective approaches in network vendor selection, allowing decision-making based on a variety of relevant criteria. MAUT provides a structured and objective framework for selecting vendors that best suit the needs and priorities of the organization, ensuring more transparent and informed decisions. Normalization is the first stage in the MAUT method, each alternative is evaluated against each criterion that has been set. This evaluation often involves measuring or calculating data normalization so that it produces values in the same range, normalization is calculated using equation (8) for criteria price and equation (7) for other criteria.

$$r_{11}^{*} = 1 + \frac{\min x_{11;15} - x_{11}}{\max x_{11;15} - \min x_{11;15}} = 1 + \frac{3-4}{5-4} = 1 + \frac{(-1)}{2} = 0.5$$

Table 4 is the result of the overall normalization calculation of the MAUT method.

Table 4. The Results of the Overall Normalization Calculation of the MAUT Method.

Vendor Name	Price	Experience	Reliability and Performance	Security Features	Assurance	Communication
Nusanet	0.5	1	0	0	1	1
MMS	1	0	0	1	1	0
Zitline	0	1	1	0.5	0	1
JPDN	0.5	0	0	0.5	1	0
TMS	0.5	1	1	0.5	0	0

Table 4 is the result of the value calculation of the matrix normalization of each alternative for the existing criteria using the MAUT method.
Calculating the utility value is the second stage in the MAUT method, each alternative will be calculated the utility value for each criterion. The utility value is calculated using equation (9).

$$u_{11} = \frac{e((r_{11}^{*})^{2}) - 1}{1.71} = \frac{e(0.5) - 1}{1.71} = \frac{1.6487 - 1}{1.71} = \frac{0.6487}{1.71} = 0.3794$$

Table 5 is the result of the overall utility value calculation of the MAUT method.

Table 5. The Results of the Overall Utility Value of the MAUT Method.

Vendor Name	Price	Experience	Reliability and Performance	Security Features	Assurance	Communication
Nusanet	0.3794	1.0048	0	0	1.0048	1.0048
MMS	1.0048	0	0	1.0048	1.0048	0
Zitline	0	1.0048	1.0048	0.3794	0	1.0048
JPDN	0.3794	0	0	0.3794	1.0048	0
TMS	0.3794	1.0048	1.0048	0.3794	0	0

Table 5 is the result of calculating the utility value of each alternative to the existing criteria using the MAUT method.
Calculating the final value of the utility is the last stage in the MAUT method, each alternative will be calculated the final value of the utility for the entire criterion. The final value of the utility is calculated using equation (10).

$$u_{(1)} = (w_1 * u_{11}) + (w_2 * u_{21}) + (w_3 * u_{31}) + (w_4 * u_{41}) + (w_5 * u_{51}) + (w_6 * u_{61})$$

$$u_{(1)} = (0.0978 * 0.3794) + (0.1561 * 1.0048) + (0.1628 * 0) + (0.1579 * 0) + (0.2693 * 1.0048) + (0.1561 * 1.0048)$$

$$u_{(1)} = 0.6214$$

$$u_{(2)} = (w_1 * u_{12}) + (w_2 * u_{22}) + (w_3 * u_{32}) + (w_4 * u_{42}) + (w_5 * u_{52}) + (w_6 * u_{62})$$

$$u_{(2)} = (0.0978 * 1.0048) + (0.1561 * 0) + (0.1628 * 0) + (0.1579 * 1.0048) + (0.2693 * 1.0048) + (0.1561 * 0)$$

$$u_{(2)} = 0.5276$$

$$u_{(3)} = (w_1 * u_{13}) + (w_2 * u_{23}) + (w_3 * u_{33}) + (w_4 * u_{43}) + (w_5 * u_{53}) + (w_6 * u_{63})$$

$$u_{(3)} = (0.0978 * 0) + (0.1561 * 1.0048) + (0.1628 * 1.0048) + (0.1579 * 0.3794) + (0.2693 * 0) + (0.1561 * 1.0048)$$

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$$u_{(3)} = 0.5371$$

$$u_{(4)} = (w_1 * u_{14}) + (w_2 * u_{24}) + (w_3 * u_{34}) + (w_4 * u_{44}) + (w_5 * u_{54}) + (w_6 * u_{64})$$

$$u_{(4)} = (0.0978 * 0.3794) + (0.1561 * 0) + (0.1628 * 0) + (0.1579 * 0.3794) + (0.2693 * 1.0048) + (0.1561 * 0)$$

$$u_{(4)} = 0.3677$$

$$u_{(5)} = (w_1 * u_{15}) + (w_2 * u_{25}) + (w_3 * u_{35}) + (w_4 * u_{45}) + (w_5 * u_{55}) + (w_6 * u_{65})$$

$$u_{(5)} = (0.0978 * 0.3794) + (0.1561 * 1.0048) + (0.1628 * 1.0048) + (0.1579 * 0.3794) + (0.2693 * 0) + (0.1561 * 0)$$

$$u_{(5)} = 0.4147$$

The final value of the utility is the final result of the MAUT method in the selection of network vendors, this result will be used in the ranking of alternative network vendors.

3.4 Alternative Rank

The combination of the CRITIC (Criteria Importance Through Intercriteria Correlation) weighting method with Multi-Attribute Utility Theory (MAUT) in the selection of network vendors is a systematic and objective approach. The CRITIC method is used to determine the weight of the criteria more accurately based on variability and conflict between criteria. The resulting weights from CRITIC provide a more objective value as they take into account the correlation between the criteria, thus ensuring that each criterion is rated according to its importance in the overall context. With the resulting weights from CRITIC, we can ensure that the evaluation of vendors is carried out by considering the relative impact of each criterion appropriately. After determining the weight of the criteria using the CRITIC method, the next step is to apply Multi-Attribute Utility Theory (MAUT) for alternative vendor ranking. In MAUT, each vendor is evaluated based on the criteria that have been weighted, then calculates its total utility value by multiplying the performance score of each criterion by the corresponding weighting and adding them up. The vendor with the highest utility score will rank first, followed by other vendors according to their score. Figure 2 is the result of the ranking of network vendors.

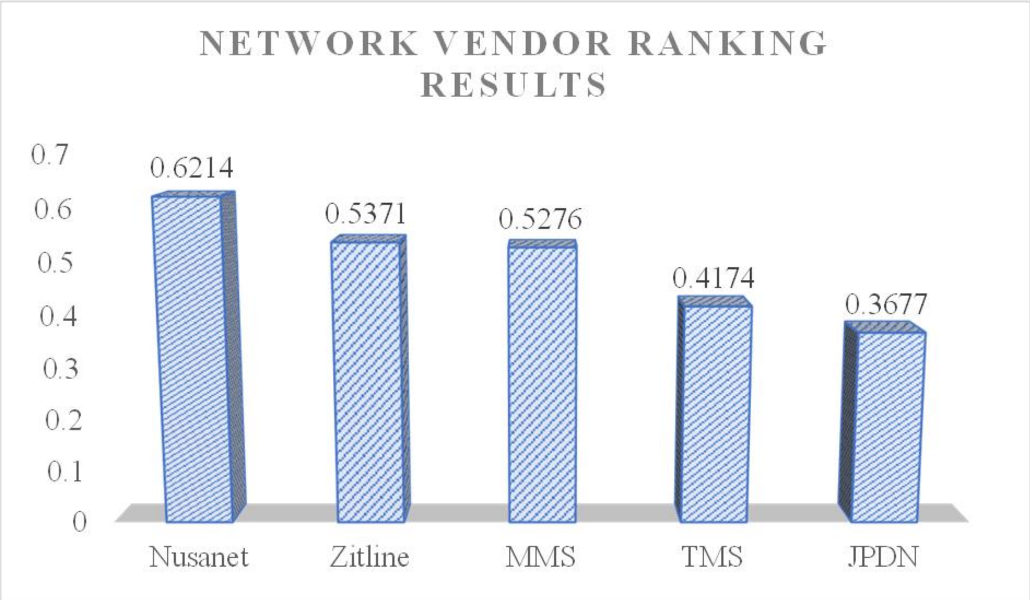

Figure 2. Network Vendor Ranking Results

The results of the network vendor ranking show Figure 2 is that Nusanet gets the first rank with a final score of 0.6214, Zitline gets the second rank with a final score of 0.5317, MMS gets the third rank with a final score of 0.5276, TMS gets the fourth rank with a final score of 0.4147, and JPDN gets the fifth rank with a final score of 0.3677. This combination of the CRITIC and MAUT methods provides a comprehensive approach to network vendor selection, ensuring that decisions are based on structured, transparent, and measurable analysis, resulting in the most optimal vendor selection for the organization's needs.

The combination of the CRITIC and MAUT Weighting Methods in the selection of network vendors offers several significant advantages. The CRITIC method provides objective weight based on variation and correlation between criteria, thereby reducing subjective judgment in the assessment process. Meanwhile, MAUT enables a

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comprehensive assessment by considering the decision-maker's preferences and the utility value of each alternative quantitatively. By combining these two methods, the vendor selection process becomes more transparent, objective, and structured, resulting in more accurate decisions that are tailored to the needs of the organization. Combining the CRITIC Weighting Method with MAUT in the selection of network vendors offers a number of significant advantages. The CRITIC method provides objective weight based on variation and correlation between criteria, thereby reducing subjective bias and ensuring that each criterion is assessed according to its actual contribution. Meanwhile, MAUT allows for a comprehensive and quantitative analysis of existing alternatives by taking into account the preferences of decision-makers and the utility value of each option. With this combination, the network vendor selection process becomes more transparent, accurate, and aligned with the organization's strategic needs, resulting in more informative and reliable decisions.

4. CONCLUSION

The combination of the CRITIC (Criteria Importance Through Intercriteria Correlation) weighting method with Multi-Attribute Utility Theory (MAUT) in the selection of network vendors is a systematic and objective approach. The CRITIC method is used to determine the weight of the criteria more accurately based on variability and conflict between criteria. The resulting weights from CRITIC provide a more objective value as they take into account the correlation between the criteria, thus ensuring that each criterion is rated according to its importance in the overall context. With the resulting weights from CRITIC, we can ensure that the evaluation of vendors is carried out by considering the relative impact of each criterion appropriately. After determining the weight of the criteria using the CRITIC method, the next step is to apply Multi-Attribute Utility Theory (MAUT) for alternative vendor ranking. In MAUT, each vendor is evaluated based on the criteria that have been weighted, then calculates its total utility value by multiplying the performance score of each criterion by the corresponding weighting and adding them up. The vendor with the highest utility score will rank first, followed by other vendors according to their score. The results of the network vendor ranking show that Nusanet gets the first rank with a final score of 0.6214, Zitline gets the second rank with a final score of 0.5317, MMS gets the third rank with a final score of 0.5276, TMS gets the fourth rank with a final score of 0.4147, and JPDN gets the fifth rank with a final score of 0.3677. This combination of the CRITIC and MAUT methods provides a comprehensive approach to network vendor selection, ensuring that decisions are based on structured, transparent, and measurable analysis, resulting in the most optimal vendor selection for the organization's needs.

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