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# IMPLEMENTATION OF THE COMPLEX PROPORTIONAL ASSESSMENT METHOD IN DETERMINING THE PLACE OF INDUSTRIAL WORK PRACTICE

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**Abstract**

Industrial Work Practices are a form of directly applying the knowledge gained in the classroom to the industrial world or the world of work. However, in its implementation, problems exist, such as workloads that must be by majors and conditions. This research uses the COPRAS method to build a decision support system to determine the place of industrial work practice at Prama Artha Private Vocational School. This method focuses on resolving each alternative's relative weight and utility and performing complex calculations proportionally. This study used 10 alternative data for internship places as samples and five criteria: student expertise, company division, distance, number of students, and type of company. The results of this study are that the PLN UP3 Pematang Siantar alternative is ranked first with a final calculation result of 100, the USI Pematang Siantar alternative is ranked second with a final calculation result of 96.29 and continued with the Tunas Bangsa STIKOM alternative with a final calculation value of 93.01. This COPRAS ranking system is based on the weights and values given to each criterion so that objectivity and accuracy are guaranteed in determining the place of internship based on the needs and abilities of students. Based on the results of black box testing of the system, it can be concluded that the system as a whole can run according to functionality and is ready for use.

**Keywords**: *DSS, COPRAS, Determination of Internship Place, Vocational High School*



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## 1. INTRODUCTION

The rapid advancement of information technology in the current era significantly impacts progress in several fields of life, including education[1][2]. Vocational high schools have an essential role in developing highly skilled human resources with various skills[3][4][5]. Information technology is essential in educational data processing, especially in vocational high schools[6][7]. This is due to the schedule of activities of SMK, which is more than other public schools. Industrial Work Practice is one of several activities that do not exist in other public schools[8].

Industrial Work Practices are a form of applying academic knowledge in the workplace to produce graduates who are ready to work and have professional skills[9][10]. In the implementation of the internship, several problems often arise, such as the workload given to students, not the students' expertise, and the distance between their homes to the internship site being too far. Hence, there are often complaints from companies due to student tardiness; in addition, the number of students accepted at one internship site is too much, making the activities carried out less optimal. Because of these problems, the implementation of the internship is not optimal and can reduce the trust of the internship site towards the school and affect student grades. In addition, the younger siblings of students who participated in the internship activities at the company may not be recommended or may even be blocked the following year.

To overcome these problems, a solution is needed, namely a Decision Support System. A Decision Support System is a system that can solve problems and simplify evaluation procedures by providing an objective basis for decision-making[11][12][13]. Because computerized calculations provide more accurate results and have been widely used to help provide system-based recommendations[14][15][16]. The Complex Proportional Assessment (COPRAS) method will be applied in this research. The COPRAS method is

usually used when making decisions involving many attributes[17]. This method focuses on determining the relative weight and utility of each alternative and performing complex calculations proportionally[18][19][20]. Thus, the decision is not too subjective and gives the appropriate weight to each criterion[21][22]. This method simultaneously describes the worst and best results ratio[23][24].

Previous research has been conducted in the selection of coffee plantations using the COPRAS method. The results of this study indicate that the COPRAS approach can solve the problem of criteria with conflicting qualities, which indicates an ideal level of selectivity. So this method can help in the selection of coffee plantation land locations in this study[25]. However, in this study, the COPRAS method will be applied in a different context, namely, to determine recommendations for industrial work practice places for students at Prama Artha Private Vocational School.

Based on the explanation above, this research aims to build a decision support system in determining the place of industrial work practice using the COPRAS method so that it can help schools and students in determining the place of industrial work practice and produce accurate recommendations for industrial work practice places so that industrial work practice activities can be carried out optimally and produce quality work-ready graduates.

## 2. RESEARCH METHOD

The stages of this research are shown in Figure 1.

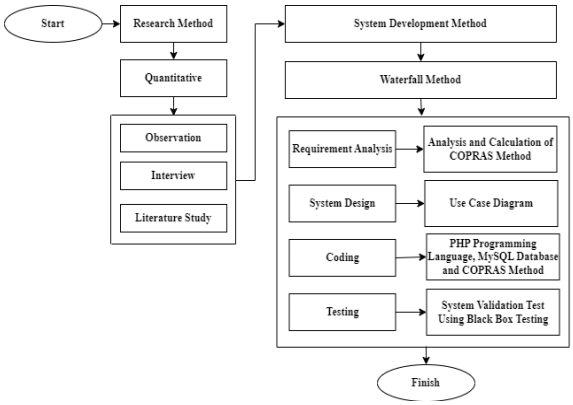


Figure 1. Research Stages

The quantitative method is a research approach that produces more measurable information because it is obtained using statistical procedures or other quantitative methods [26]. The following is an explanation of the data sources in this study.

a. Observation: Observations were conducted at SMK Swasta Prama Artha, Jl. Pasar 2 Bahapal, Bandar Huluan, Simalungun Regency. Observation aims to understand the ongoing process, identify problems directly, and observe the solutions applied.
b. Interview: The data and criteria used in this study were obtained through interviews with Mr. Supriadi, S.pd. as PKS Student Affairs, to obtain information related to data on criteria for determining the place of Industrial Work Practice.
c. Literature Study: In addition, the authors also collect additional information from various sources, such as journals and previous research, which are used as references and references in this study.

This research uses the Waterfall method for system development. The waterfall method in system development is carried out sequentially following a series of steps that must be completed sequentially[27]. The following are the steps in the waterfall method.

a. Requirement Analysis: This stage involves analyzing system requirements by collecting data. This section will also explain the calculations using the COPRAS method.
b. System design: System design is carried out using UML, which consists of use case diagrams, activity diagrams, and class diagrams.
c. Coding: At this stage, a decision support system is built using the COPRAS method to determine the Industrial Work Practice Place using the PHP programming language and MySQL database.
d. Testing: In this study, system testing was carried out using black box testing to determine whether the system could run properly or not.
e. Maintenance: At this stage, after the system is successfully created, users can operate and maintain the software. However, this research did not reach the maintenance stage.

In 1994, Zavadskas and Kaklauskas established the COPRAS method, which is a quantitative and qualitative criteria evaluation approach[28][29][30]. Before carrying out the stages of the COPRAS method, criteria and alternatives based on needs must be determined first[31]. The following are the steps in the COPRAS approach after the criteria are determined[32]:

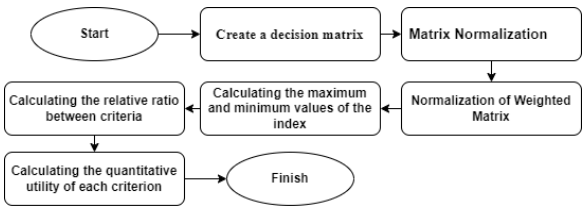


Figure 2. Steps of the COPRAS Method

1. Create a decision matrix

$$X = [x_{ij}]_{mxn} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (1)$$

i is the i-th alternative, j is the j-th criterion, m is the number of matrices (matrix length), and n is the number of criteria (matrix width).

2. Matrix Normalization

$$R = [r_{ij}]_{mxn} = x_{ij} \ / \ \sum_{i=1}^{m} x_{ij} \quad (2)$$

3. Normalization of Weigthed Matrix

$$X = [x_{ij}]_{mxn} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (3)$$

The weight of a criterion is symbolized by w, and the criterion value of the normalized matrix is symbolized by r.

4. Calculate the maximum and minimum values of the index

$$S_{+i} = \sum_{j=1}^{n} y_{+ij}, S_{-i} = \sum_{j=1}^{n} y_{-ij} \quad (4)$$

The number of criteria that are favorable for $S_{+i}$, then criteria that are unfavorable for $S_{-i}$, is symbolized by n, and the normalized criteria value multiplied by the matrix weight is symbolized by y.

5. Calculating the relative ratio or relative significance (Qi)

$$Q_i = S_{+i} + \frac{1 \cdot \sum_{i=1}^{m} S_{-1}}{S_{-1} \cdot \sum_{i=1}^{m} (1 \ / \ S_{-i})}, i = 1,..,m \quad (5)$$

The favorable criterion value of the i-th alternative is symbolized $S_{+i}$, the unfavorable criterion value is symbolized $S_{-i}$, and the smallest value of all values is symbolized $S_{-min}$.

6. Calculate the quantitative utility level (Ui) of each alternative

$$U_i = \frac{Q_i}{Q_{max}} \cdot 100\% \quad (6)$$

Where the maximum value of all Q on all alternatives is symbolized by $Q_{max}$. The result of this stage is the percentage for all alternative values.

## 3. RESULTS AND DISCUSSION

### 3. 1 Analysis and Calculation of Complex Proportional Assessment Method

In determining the place of practical internship using the COPRAS method, data on the place of practical internship is used. Information regarding data and criteria in this study was obtained from interviews with Mr. Supriadi, S.pd. as PKS Student Affairs at Prama Artha Private Vocational School. In this study's calculation using the COPRAS method, 10 data on internship sites were used as samples. The data of the practical internship place used as a sample is the data of the practical internship place in the Software Engineering department, which is calculated and will be an example of calculations for other departments. The following are alternative data used in the calculation of the COPRAS method.

Table 1. Alternative Value Data

| ID | Company Name | Student Skill | Company Division | Distance | Number of Students | Company Type |
|---|---|---|---|---|---|---|
| A1 | USI PEMATANG SIANTAR | Suitable Enough | Not suitable | 31 KM | 7 Persons | Not a Government/State-Owned Enterprise |
| A2 | STIKOM TUNAS BANGSA | Very Suitable | Not suitable | 29 KM | 5 Persons | Not a Government/State-Owned Enterprise |
| A3 | MURNI SADAR P.SIANTAR | Very Suitable | Not suitable | 28 KM | 4 Persons | Not a Government/State-Owned Enterprise |
| A4 | PT PMN RS. LARAS | Suitable Enough | Not suitable | 600 M | 5 Persons | State-Owned Enterprise |
| A5 | PTPN IV DOLOK ILIR | Suitable Enough | Suitable | 2,3KM | 5 Persons | State-Owned Enterprise |
| A6 | DJP PEMATANG SIANTAR | Suitable Enough | Suitable | 30 KM | 3 Persons | District/City Government Agency |
| A7 | BPD BANDAR HULUAN | Not suitable | Not suitable | 1,3 KM | 3 Persons | Local Government Agency |
| A8 | PLN UP3 PEMATANG SIANTAR | Suitable Enough | Suitable | 30 KM | 5 Persons | State-Owned Enterprise |
| A9 | KANTOR CAMAT BANDAR HULUAN | Not suitable | Not suitable | 1,7 KM | 5 Persons | Local Government Agency |

| | | | | | | |
|---|---|---|---|---|---|---|
| A10 | UPTD DOBANA | Suitable Enough | Not suitable | 4,2 KM | 4 Persons | Local Government Agency |

Determining criteria and parameters for problem assessment is the first stage of using the Complex Proportional Assessment method (COPRAS). The following are the criteria and weights that are the basis for calculations in this study in determining the place of internship.

Table 2. Criteria data

| ID | Criteria Name | Type | Weight |
|---|---|---|---|
| C1 | Student Skill | Benefit | 30% |
| C2 | Company Division | Benefit | 15% |
| C3 | Distance | Cost | 30% |
| C4 | Number of Students | Cost | 15% |
| C5 | Company Type | Benefit | 10% |

The next step is to determine the weight of all criteria. The following is the weight of all criteria given a value.

Table 3. Sub Criteria

| ID | Criteria Name | Sub Criteria | Weight |
|---|---|---|---|
| C1 | Student Skill | Not suitable | 1 |
| | | Suitable Enough | 2 |
| | | Very Suitable | 3 |
| C2 | Company Division | Suitable | 2 |
| | | Not suitable | 1 |
| C3 | Distance | <5 KM | 3 |
| | | 6-10 KM | 2 |
| | | >11 KM | 1 |
| C4 | Number of Students | 1-3 Persons | 3 |
| | | 4-6 Persons | 2 |
| | | >6 Persons | 1 |
| C5 | Company Type | State-Owned Enterprise | 4 |
| | | District/City Government Agency | 3 |
| | | Local Government Agency | 2 |
| | | Not a Government/State-Owned Enterprise | 1 |

The following is a calculation to determine the place of internship using the COPRAS approach. The following are the steps used in solving problems using the COPRAS method:

1. Determining the Criteria Value of Each Alternative

The table below shows the assessment of alternatives for each criterion. The weight given to each sub-criterion was previously used to determine the value for each criterion.

Table 4. Criteria Value Data

| ID | Alternative Name | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|---|
| A1 | USI PEMATANG SIANTAR | 2 | 1 | 1 | 1 | 1 |
| A2 | STIKOM TUNAS BANGSA | 3 | 1 | 1 | 2 | 1 |
| A3 | MURNI SADAR P.SIANTAR | 3 | 1 | 1 | 2 | 1 |
| A4 | PT PMN RS. LARAS | 2 | 1 | 3 | 2 | 4 |
| A5 | PTPN IV DOLOK ILIR | 2 | 2 | 3 | 2 | 4 |
| A6 | DJP PEMATANG SIANTAR | 2 | 2 | 1 | 3 | 3 |
| A7 | BPD BANDAR HULUAN | 1 | 1 | 3 | 3 | 2 |
| A8 | PLN UP3 PEMATANG SIANTAR | 2 | 2 | 1 | 2 | 4 |
| A9 | KANTOR CAMAT BANDAR HULUAN | 1 | 1 | 3 | 2 | 2 |
| A10 | UPTD DOBANA | 2 | 1 | 3 | 2 | 2 |

2. Normalization of Decision Matrix

Equation (2) is used to normalize the decision matrix based on the criteria value of each alternative. If, $\sum C1 = (2 + 3 + 3 + 2 + 2 + 2 + 1 + 2 + 1 + 2) = 20$ for example $A_{1,1} = \frac{2}{20} = 0{,}1$. The results of the decision matrix calculation for each criterion value for each alternative are listed below.

Table 5. Normalization of Decision Matrix

| ID | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| A1 | 0.1 | 0.076923 | 0.05 | 0.047619 | 0.041667 |
| A2 | 0.15 | 0.076923 | 0.05 | 0.095238 | 0.041667 |
| A3 | 0.15 | 0.076923 | 0.05 | 0.095238 | 0.041667 |
| A4 | 0.1 | 0.076923 | 0.15 | 0.095238 | 0.166667 |
| A5 | 0.1 | 0.153846 | 0.15 | 0.095238 | 0.166667 |
| A6 | 0.1 | 0.153846 | 0.05 | 0.142857 | 0.125 |
| A7 | 0.05 | 0.076923 | 0.15 | 0.142857 | 0.083333 |
| A8 | 0.1 | 0.153846 | 0.05 | 0.095238 | 0.166667 |
| A9 | 0.05 | 0.076923 | 0.15 | 0.095238 | 0.083333 |
| A10 | 0.1 | 0.076923 | 0.15 | 0.095238 | 0.083333 |

3. Normalization of Weighted Matrix

In this step, the normalized decision matrix is calculated using the weight value of each criterion and then connected to the table using equation (3). For example, if C1 has a weight of 0.3, then $A_{1,1} = 0{,}1\ x\ 0{,}3 = 0{,}03$. The subsequent calculations are shown in Table 6 below.

Table 6. Normalization of Weighted Matrix

| ID | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| A1 | 0.03 | 0.011538 | 0.015 | 0.007143 | 0.004167 |
| A2 | 0.045 | 0.011538 | 0.015 | 0.014286 | 0.004167 |
| A3 | 0.045 | 0.011538 | 0.015 | 0.014286 | 0.004167 |
| A4 | 0.03 | 0.011538 | 0.045 | 0.014286 | 0.016667 |
| A5 | 0.03 | 0.023077 | 0.045 | 0.014286 | 0.016667 |
| A6 | 0.03 | 0.023077 | 0.015 | 0.021429 | 0.0125 |
| A7 | 0.015 | 0.011538 | 0.045 | 0.021429 | 0.008333 |
| A8 | 0.03 | 0.023077 | 0.015 | 0.014286 | 0.016667 |
| A9 | 0.015 | 0.011538 | 0.045 | 0.014286 | 0.008333 |
| A10 | 0.03 | 0.011538 | 0.045 | 0.014286 | 0.008333 |

4. Calculate the maximum and minimum values of the index

Equation (4) is used to calculate the value of maximizing the S+1 index, and this process is done by summing C1 and C2 for each alternative (A1-A10). In this calculation, only the sum of C1 and C2 is the benefit criteria. And for the value of minimizing the S-1 index is done by summing C3, C4, and C5 for each alternative (A1-A10) with equation (4). This calculation uses C3, C4, and C5, which are cost criteria. The following are the results of the calculation for all alternatives.

Table 7. Maximum and Minimum index score results

| Alternative | S+ | S- |
|---|---|---|
| A1 | 0.045705 | 0.022143 |
| A2 | 0.060705 | 0.029286 |
| A3 | 0.060705 | 0.029286 |
| A4 | 0.058205 | 0.059286 |
| A5 | 0.069744 | 0.059286 |
| A6 | 0.065577 | 0.036429 |
| A7 | 0.034872 | 0.066429 |
| A8 | 0.069744 | 0.029286 |
| A9 | 0.034872 | 0.059286 |
| A10 | 0.049872 | 0.059286 |
| | $\sum_{i=1}^{m} S_{-1}$ | 0.45 |

Furthermore, the relative weight of each alternative is calculated. The calculation results are shown in Table 8 below.

Table 8. Results relative weight calculation

| Alternative | 1/S-i | S-i*Total 1/Si |
|---|---|---|
| A1 | 45.16129 | 5.703445 |
| A2 | 34.14634 | 7.543266 |
| A3 | 34.14634 | 7.543266 |
| A4 | 16.86747 | 15.27051 |
| A5 | 16.86747 | 15.27051 |
| A6 | 27.45098 | 9.383087 |
| A7 | 15.05376 | 17.11034 |
| A8 | 34.14634 | 7.543266 |
| A9 | 16.86747 | 15.27051 |
| A10 | 16.86747 | 15.27051 |
| Total | 257.5749 | |

5. Calculating the Relative Significance Value (Qi)

At this stage is the result of determining the Qi value generated using equation (5). The following are the results of determining the Qi value.

Table 9. Relative Significance Value

| Alternative | $S_{+i} + \frac{1 \cdot \sum_{i=1}^{m} S_{-1}}{S_{-1} \cdot \sum_{i=1}^{m} (1 \ / \ S_{-i})}$ |
|---|---|
| A1 | 0.124605 |
| A2 | 0.120361 |
| A3 | 0.120361 |
| A4 | 0.087674 |
| A5 | 0.099212 |
| A6 | 0.113536 |
| A7 | 0.061172 |
| A8 | 0.129399 |
| A9 | 0.06434 |
| A10 | 0.07934 |
| $Q_{max}$ | 0.129399 |

6. Calculating Quantitative Utiility (Ui) of each alternative

The Quantitative Utility (Ui) for each alternative, as determined by equation (6), is shown in the table below.

Table 10. Quantitative utility calculation results

| Alternative | Ui | Rank |
|---|---|---|
| A1 | 96.2947 | 2 |
| A2 | 93.01507 | 3 |
| A3 | 93.01507 | 3 |
| A4 | 67.7543 | 7 |
| A5 | 76.67123 | 6 |
| A6 | 87.74037 | 5 |
| A7 | 47.27353 | 10 |
| A8 | 100 | 1 |
| A9 | 49.72228 | 9 |
| A10 | 61.31429 | 8 |

### 3. 2 System Design

The system workflow is designed using the Unified Modeling Language (UML). UML is a modeling language that uses concepts from object-oriented programming[33]. One of the UML diagrams used in this research is the use case diagram. A use case diagram is a description of the form of interaction between actors and the system[34]. There are two users in the system, namely the admin who can manage industrial work practice place data and users or students who can only see the ranking results in the form of industrial work practice place recommendations. The use case diagram can be seen in Figure 4 below.

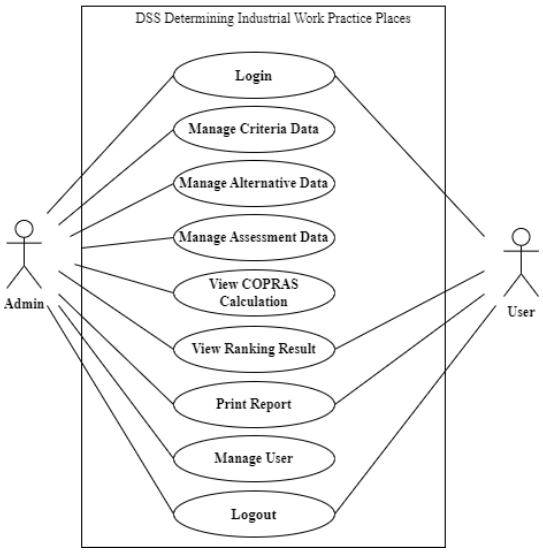


Figure 3. Use Case Diagram

### 3. 3 Implementation of Web-based Complex Proportional Assessment Method

1. Input Criteria and Criteria Weights

On this page, input criteria and sub criteria and their values into the system. The weight and type of criteria must also be inputted in this section.

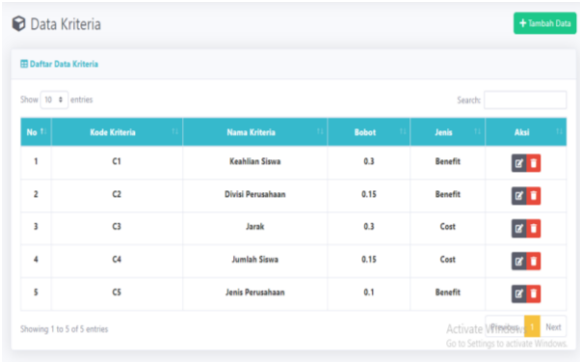


Figure 4. Criteria Data Page

2. Alternative Data Input

After inputting the sub-criteria, you can enter alternatives on the alternative menu. The alternative data that is inputted is the data of the internship site.

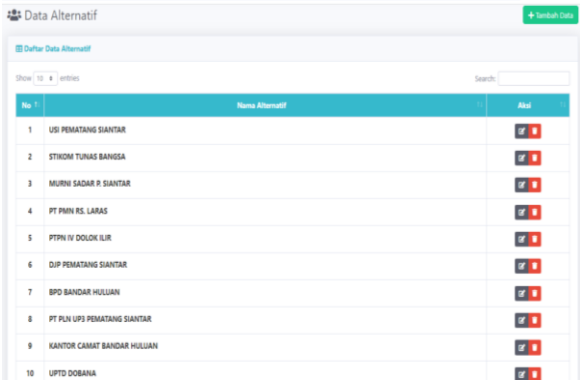


Figure 5. Alternative Data Page

3. Assessment Data Input

Input assessment data for each criterion to all alternative data required on this page.

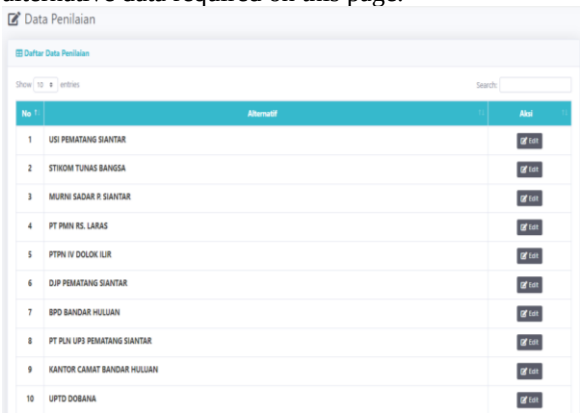


Figure 6. Assessment Data Page

4. Calculation Page

On this page, the calculation process is carried out to obtain ranking results from the matrix normalization process, normalization of the weighted matrix, calculating the maximum and minimum values of the index, the significance of the relative weight, and calculating the quantitative (Ui) for each alternative.

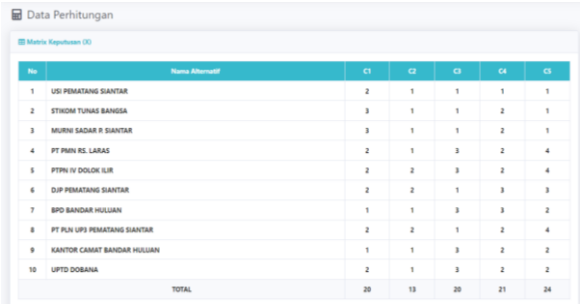


Figure 7. Calculation Page

5. Final Calculation Result

On the final page of this calculation, the alternative that gets the highest score is considered the best choice.

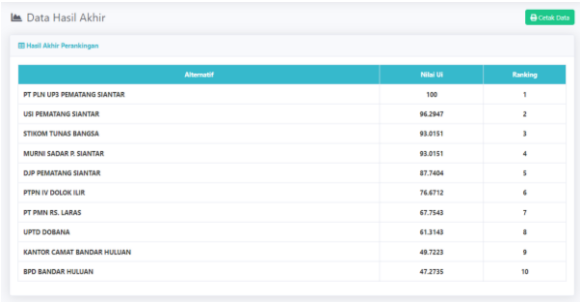


Figure 8. Final Calculation Result Page

Based on the ranking in manual calculations, the PLN UP3 Pematang Siantar system is placed in the first place as an alternative with the best value. Therefore, the ranking results using the calculation of the COPRAS method can help determine recommendations for internship places at Prama Artha Private Vocational School.

### 3. 4 System Testing

Once the system has been built, the next step is to test the system to ensure no errors. Testing is done using the black-box testing method, which evaluates the system's functionality. The results of black-box testing can be seen in Table 11 below.

Table 11. System Testing

| No | Test Feature | Expected Result | Conclusion |
|---|---|---|---|
| 1 | Login Page | Users can log in to the system by using a username and password. | Valid |
| 2 | Main Menu | Main menu can be displayed. | Valid |
| 3 | Criteria and Sub-Criteria Menu | Users can manage criteria and sub-criteria, including adding, editing, and deleting criteria and sub-criteria. | Valid |
| 4 | Alternative Menu | Users can manage alternatives, including adding, editing, and deleting alternatives. | Valid |
| 5 | Value Menu | Users can manage grades, including adding, editing, and deleting grades. | Valid |
| 6 | COPRAS Calculation Menu | Users can see the calculation process using the COPRAS method. | Valid |
| 7 | Best Alternative Result | Users can see the ranking results and system recommendations for the best alternative. | Valid |

In research with the same case, it has previously been tested using a different method, namely the SAW method[35]. However, the difference is in the criteria used and the final result. The criteria used in the study focused more on the infrastructure of the internship site, such as the availability of temporary housing, cleanliness, and the area of the internship site. This causes the chosen internship place to be incompatible with the student's career goals, and the number of students in one internship place can be too large. Therefore, there are differences in this study, where the criteria for the type of company are used. If the company's reputation is good, it will be more recommended, and the criteria for the number of students in one company is not too large so that industrial work practice activities can be carried out optimally.

## 4. CONCLUSION

According to the research findings, to determine the place of internship at SMK Swasta Prama Artha can be found by using the COPRAS approach based on five criteria: student skill (C1), company division (C2), distance (C3), number of students (C4), and type of company (C5). Based on the research results, the PLN UP3 Pematang Siantar alternative is ranked first as the best quality alternative with the highest score, followed by the USI Pematang Siantar alternative in second place and the STIKOM Tunas Bangsa alternative in third place. This ranking system is based on predetermined criteria and can be used to determine recommendations for appropriate internship places.

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