

Implementation of the Complex Proportional Assessment Method In Determining the Place of Industrial Work Practice.docx

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Submission date: 15-Jul-2024 02:32PM (UTC+0700)

Submission ID: 2417128823

File name:

Implementation_of_the_Complex_Proportional_Assessment_Method_In_Determining_the_Place_of_Industrial_Work_Practice.docx
(768.38K)

Word count: 4380

Character count: 23918

taken is not too subjective and gives the appropriate weight to each criterion [20][21]. This method also describes the ratio of the worst and best results simultaneously [22][23].

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 [24]. 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 Prakerin activities can be carried out optimally and produce quality work-ready graduates.

2. RESEARCH METHOD

The following are the stages of this research.

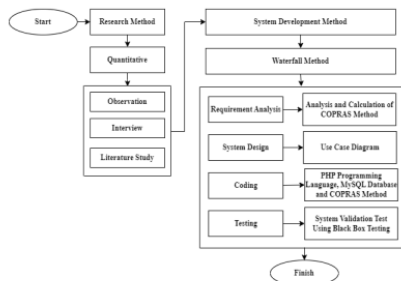


Figure 1: Research Stages

Quantitative method is a research approach that produces more measurable information because it is obtained using statistical procedures or other quantitative methods [25]. The following is an explanation of the data sources in this study.

1. Observation: Observations were conducted at SMK Swasta Prama Artha, Jl. Pasar 2 Bahapal, Bandar Huluan, Simelungur Regency.

2. 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.
3. 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 [26]. The following are the steps in the waterfall method.

1. Requirement Analysis: This stage involves analyzing system requirements by collecting data. In this section will also explain the calculations using the COPRAS method.
2. System design: System design is carried out using UML which consists of use case diagrams, activity diagrams and class diagrams.
3. 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.
4. Testing: In this study, system testing was carried out using black box testing to determine whether the system could run properly or not.
5. 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 [27][28][29]. Before carrying out the stages of the COPRAS method, criteria and alternatives based on needs must be determined first [30]. The following are the steps in the COPRAS approach after the criteria are determined[31]:

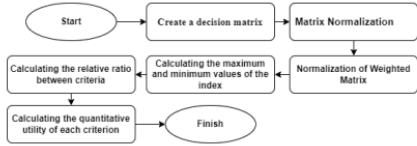


Figure 2: Steps of the COPRAS Method

1. Create a decision matrix.

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

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

2. Matrix Normalization

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

3. Normalization of Weighted Matrix

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

The weight of a criterion is symbolized by w_j and the criterion value of the normalized matrix is symbolized by r_{ij} .

4. Calculate the maximum and minimum values of the index.

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

The number of criteria that are favorable for S_+ , then criteria that are unfavorable for S_- is symbolized by n_+ and the normalized criteria value multiplied by the matrix weight is symbolized by y_{ij} .

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

$$Q_i = S_+ / \left(S_+ + \frac{1 \cdot \sum_{j=1}^{n_+} S_{-j}}{S_{-i} \cdot \sum_{j=1}^{n_+} (1/S_{-j})} \right), i = 1, \dots, m \quad (5)$$

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

6. Calculate the quantitative utility level (U_i) 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 the calculation using the COPRAS method in this study, 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 department. 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 in 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 that have been given a value.

Table 3. Sub Criteria

ID	Criteria Name	Sub Criteria	Weight
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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	29	1
		1-3 Persons	3
		4-6 Persons	2
C5	Company Type	>6 Persons	1
		State-Owned Enterprise	4
		District/City Government Agency	3
		Local Government Agency	2

Not a Government/State-Owned Enterprise	1
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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 $A_{1,1} = 0,1 \times 0,3 = 0,03$. 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
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4. Calculate the maximum and minimum values of the index.

Equation (4) is used to calculate the value of maximizing the S+1 index, 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). In this calculation C3, C4 and C5 are used 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, relative weight of each alternative is calculated. The calculation results are shown in Table 8 below.

Table 8. Results of relative weight calculation

Alternative	I/S-i	S-i*Total I/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 Utility (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[32]. One of the UML diagrams used in this research is the use case diagram. Use case diagram is a description of the form of interaction between actors and the system[33]. There are two users in the system, namely the admin who can manage **prakerin** place data and users or students who can only see the ranking results in the form of **prakerin** 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 Data 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.

No.	Nama Kriteria	Sub Kriteria	Bobot	Jenis	Aksi
1	C1	Kemampuan Dasar	0.3	Benefit	[+]
2	C2	Modal Persewaan	0.15	Benefit	[+]
3	C3	Jarak	0.3	Cost	[-]
4	C4	Jumlah Siswa	0.15	Cost	[-]
5	C5	Jenis Persewaan	0.1	Benefit	[+]

Figure 3. Criteria Data Page

2. Alternative Data Input

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

No.	Nama Alternatif	Aksi
1	UD PRABANDI SANGAT	[+]
2	STUDIUM TUNGGAL BANGSA	[+]
3	MURAH SANGAT & SANGAT	[+]
4	PT PRABDI LABANG	[+]
5	PTPI INI DOKUM LUK	[+]
6	SDP PRABANDI SANGAT	[+]
7	SDP BANGSA HOLLAND	[+]
8	PT PLS LPP PRABANDI SANGAT	[+]
9	KANTOR CEMETI BANGSA HOLLAND	[+]
10	UPDI BANGSA	[+]

Figure 4. Alternative Data Page

3. Assessment Data Input

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

No.	Alternatif	Aksi
1	UD PRABANDI SANGAT	[+]
2	STUDIUM TUNGGAL BANGSA	[+]
3	MURAH SANGAT & SANGAT	[+]
4	PT PRABDI LABANG	[+]
5	PTPI INI DOKUM LUK	[+]
6	SDP PRABANDI SANGAT	[+]
7	SDP BANGSA HOLLAND	[+]
8	PT PLS LPP PRABANDI SANGAT	[+]
9	KANTOR CEMETI BANGSA HOLLAND	[+]
10	UPDI BANGSA	[+]

Figure 5. 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, calculate the maximum and minimum values of the index, the significance of the relative weight and calculate the quantitative (U_i) for each alternative.

No	Nama Alternatif	C1	C2	C3	C4	C5
1	UIN PEMANGKASARI BANGKAR	2	1	1	1	1
2	STROMAN TUNGGAL BANGKAR	3	1	1	2	1
3	MAJLIS SAKSI BANGKAR	3	1	1	2	1
4	PT PANIN EL LARAS	2	1	3	2	4
5	PTPN IV DOKUR LUR	2	2	3	2	4
6	DUP PEMANGKASARI BANGKAR	2	2	1	3	3
7	BPD BANGKAR HULLAH	1	1	3	3	2
8	PT POLI LAY PEMANGKASARI BANGKAR	2	2	1	3	4
9	KANTOR CASAMAT BANGKAR HULLAH	1	1	3	2	2
10	UPTD DIBANBA	2	1	3	2	2
TOTAL		20	19	28	21	24

Figure 6. 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.

No	Nama Alternatif	Nilai C1	Ranking
1	PT POLI LAY PEMANGKASARI BANGKAR	100	1
2	UIN PEMANGKASARI BANGKAR	86,2857	2
3	STROMAN TUNGGAL BANGKAR	86,0351	3
4	MAJLIS SAKSI BANGKAR	86,0351	4
5	DUP PEMANGKASARI BANGKAR	87,7643	5
6	PTPN IV DOKUR LUR	78,8712	6
7	PT PANIN EL LARAS	87,7643	7
8	UPTD DIBANBA	81,3142	8
9	KANTOR CASAMAT BANGKAR HULLAH	48,7223	9
10	BPD BANGKAR HULLAH	87,2723	10

Figure 7. Final Calculation Result Page

Based on the ranking in manual calculations and the PLN UP3 Pematang Siantar system is placed in first place as an alternative with the best value. Therefore, the results of ranking using the calculation of the COPRAS method can be used to 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 that there are no errors. Testing is done using the black-box testing method, which evaluates the functionality of the system. 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 Verb (ETS)

Users can manage criteria and sub-criteria, including adding, editing, and deleting criteria and sub-criteria. Valid Verb (ETS)

3 Criteria and Sub-Criteria Menu Missing "," (ETS)

Users can manage alternatives, including adding, editing, and deleting alternatives. Valid Verb (ETS)

Users can manage grades, including adding, editing, and deleting grades. Valid Verb (ETS)

5 Value Menu Wrong Article (ETS)

Users can see the calculation process using the COPRAS method. Valid Missing "," (ETS)

6 Calculation Menu Best Alternative Result Articles for the best alternative. Valid Sp. (ETS)

In research with the same case, it has previously been tested using a different method, namely the SAW method [34]. However, the difference is seen 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 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, which if the company's reputation is good, it will be more recommended and the criteria for the number of students so that the number of students in one

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company is not too large so that Prakerin 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: workload (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 STIKM 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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