



**DETERMINING THE BEST SUPPLIER BY USING
ANALYTICAL HIERARCHY PROCESS (AHP)
METHOD AND ORDINAL PRIORITY APPROACH
(OPA) METHOD**

UNDERGRADUATE FINAL PROJECT

Submitted as one of the requirements to obtain Sarjana Teknik (S.T.)

**By
Nabila Alyssa Yasmin
ID No. 004201900027**

**FACULTY OF ENGINEERING
INDUSTRIAL ENGINEERING STUDY PROGRAM
CIKARANG
JUNE, 2023**

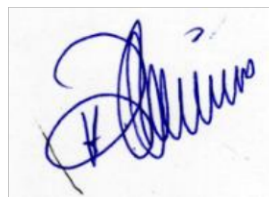
PANEL OF EXAMINER APPROVAL

The Panel of Examiners declare that the undergraduate thesis entitled **Determining the Best Supplier by Using Analytical Hierarchy Process (AHP) Method and Ordinal Priority Approach (OPA) Method** that was submitted by Nabila Alyssa Yasmin majoring in Industrial Engineering from the Faculty of Engineering was assessed and approved to have passed the Oral Examination on June 15th, 2023.

Panel of Examiner

A handwritten signature in black ink, appearing to read 'Hery Hamdi Azwir', with a long horizontal stroke extending to the right.

Ir. Hery Hamdi Azwir, M.T.
Chair of Panel Examiner


A handwritten signature in blue ink, appearing to read 'Anastasia Lidya Maukar', with a long horizontal stroke extending to the right.

Anastasia Lidya Maukar, S.T., M.Sc., M.MT.
Examiner I

FINAL PROJECT ADVISOR RECOMMENDATION LETTER

This final project entitled “**DETERMINING THE BEST SUPPLIER BY USING ANALYTICAL HIERARCHY PROCESS (AHP) METHOD AND ORDINAL PRIORITY APPROACH (OPA) METHOD**” prepared and submitted by **Nabila Alyssa Yasmin** in partial fulfillment of the requirements for the degree of Bachelor Degree in the Faculty of Engineering has been reviewed and found to have satisfied the requirements for a final project fit to be examined. I therefore recommend this final project for Oral Defense.

Cikarang, Indonesia, June 15th, 2023

A handwritten signature in blue ink, appearing to read 'A. Saptari', enclosed in a rectangular box.

Ir. Adi Saptari, M.Sc., Ph.D.

STATEMENT OF ORIGINALITY

In my capacity as an active student of President University and as the author of the thesis/final project/business plan stated below:

Name : Nabila Alyssa Yasmin
Student ID number : 004201900027
Study Program : Industrial Engineering
Faculty : Engineering

I hereby declare that my thesis/final project/business plan entitled "**Determining the Best Supplier by Using Analytical Hierarchy Process (AHP) Method and Ordinal Priority Approach (OPA) Method**" is to the best of my knowledge and belief, an original piece of work based on sound academic principles. If there is any plagiarism detected in this thesis/final project/business plan, I am willing to be personally responsible for the consequences of these acts of plagiarism, and will accept the sanctions against these acts in accordance with the rules and policies of President University.

I also declare that this work, either in whole or in part, has not been submitted to another university to obtain a degree.

Cikarang, June 15th, 2023



(Nabila Alyssa Yasmin)

SCIENTIFIC PUBLICATION APPROVAL FOR ACADEMIC INTEREST

As an academic community member of the President's University, I, the undersigned:

Name : Nabila Alyssa Yasmin
Student ID number : 004201900027
Study program : Industrial Engineering

for the purpose of development of science and technology, certify, and approve to give President University a non-exclusive royalty-free right upon my final report with the title:

Determining the Best Supplier by Using Analytical Hierarchy Process (AHP) Method and Ordinal Priority Approach (OPA) Method

With this non-exclusive royalty-free right, President University is entitled to converse, to convert, to manage in a database, to maintain, and to publish my final report. There are to be done with the obligation from President University to mention my name as the copyright owner of my final report.

This statement I made in truth.

Cikarang, June 15th, 2023



(Nabila Alyssa Yasmin)

ADVISOR APPROVAL FOR JOURNAL/INSTITUTION'S REPOSITORY

As an academic community member of the President's University, I, the undersigned:

Name : Ir. Adi Saptari, M.Sc., Ph.D.

ID number : 9903000334

Study program : Industrial Engineering

Faculty : Engineering

declare that following final project:

Title of final project : **Determining the Best Supplier by Using Analytical Hierarchy Process (AHP) Method and Ordinal Priority Approach (OPA) Method**

Final Project author : Nabila Alyssa Yasmin

Student ID number : 004201900027

will be published in **journal/institution's repository**.

Cikarang, June 15th, 2023



(Ir. Adi Saptari, M.Sc., Ph.D.)

**DETERMINING THE BEST SUPPLIER BY USING
ANALYTICAL HIERARCHY PROCESS (AHP)
METHOD AND ORDINAL PRIORITY APPROACH
(OPA) METHOD**

By

**Nabila Alyssa Yasmin
ID No. 004201900027**

Approved by



Ir. Adi Saptari, M.Sc., Ph.D.
Final Project Advisor



Ir. Andira Taslim, M.T
Program Head of Industrial Engineering

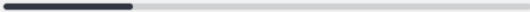
SIMILARITY CHECKING RESULT

Final Project-Nabila Alyssa Yasmin-Rev00-T			
ORIGINALITY REPORT			
10%	8%	7%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS
PRIMARY SOURCES			
1	coek.info Internet Source		1%
2	www.researchgate.net Internet Source		1%
3	link.springer.com Internet Source		1%
4	Submitted to President University Student Paper		<1%
5	Enrique Mu, Milagros Pereyra-Rojas. "Practical Decision Making using Super Decisions v3", Springer Science and Business Media LLC, 2018 Publication		<1%
6	www.its.ac.id Internet Source		<1%
7	Bartosz Paradowski, Zdzisław Szyjewski. "Comparative analyses of multi-criteria methods in supplier selection problem", Procedia Computer Science, 2022 Publication		<1%

AI BASED PLAGIARISM CHECKING RESULT

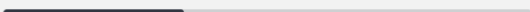
Stats

Average Perplexity Score: 246.023



A document's perplexity is a measurement of the randomness of the text

Burstiness Score: 343.034



A document's burstiness is a measurement of the variation in perplexity

Your sentence with the highest perplexity, "The nature of winning score magnitude score gap are out of discussion.", has a perplexity of: 1527

© 2022-2023 GPTZero

ABSTRACT

In daily practice, normally purchasing department deal with so many suppliers. These suppliers have so many variations in performance and specification profiles. This fact leads Purchasing Department to complex situations since it involves multi-criteria decision-making in selecting the best suppliers. This issue is critical to Supply Chain Management. To help the purchasing department in selecting the best supplier, this research applies two methods i.e. Analytical Hierarchical Process (AHP) and Ordinal Priority Approach (OPA). Executing these complete processes steps can clarify the issues on how to develop the criteria based on the perceptions of the decision makers for the supplier selection, on how to select the supplier based on Multi-Criteria Decision-Making (MCDM) using AHP and OPA methods. Two projects were evaluated on the process selection of the best supplier, each project has 3 candidates. The results show that both AHP and OPA methods provide the same rank of suppliers, even though it has different values.

Keywords: *MCDM, AHP, OPA, Supply Chain Management, Supplier Selection, Purchasing.*

ACKNOWLEDGMENT

In the name of Allah SWT the most merciful and the most graceful, and may all pleases be upon Prophet Muhammad. Finally, the researcher, now very pleased after completing this final project. Let the researcher shares the joyful feeling with the readers. The researcher also would like to express my deepest gratitude to:

1. My beloved family, My father Wiyoto Wibisiono, my mother Lely Nurwulan, my little sister Nasywa Aisyah Fatchiah, my grandmother Hj. Yoyoh Fatimah, Aunty Dian and family, and Uncle Hari and family, who never stop praying, giving full support, and happiness so that the researcher can successfully complete this final project
2. Mr. Ir. Adi Saptari, M.Sc., Ph.D. who always provides guidance, direction, and advice for the success of this final project to the end
3. Madam Ir. Andira Taslim, M.T. as the Head of Study Program of Industrial Engineering and all of the lecturers and staff of Industrial Engineering President University
4. Mr. Rifqy Isnanda and Mr. Irwan Satia Syailendra as the owner of PT. SUA
5. Mr. Ir. Hendrawan, as Manager of Human Resource Department of PT. Sarana Utama Adimandiri who gave me the opportunity to take part in an internship at PT. SUA
6. All of the employees of PT. SUA, especially all of the Purchasing Staff; Mr. Sonny Hari Mukti as my internship supervisor who has always been patient in giving me directions and giving me lots of help and advice regarding this report. Mr. Supriyatna as the Manager of Purchasing Department, Mr. Endang, Mrs. Rina, Mr. Dian, Mr. Ami, Mr. Warisman, Mr. Eef, and Mr. Odi, and others who are always willing to guide and help me during my internship
7. Nadhiva Fahriani, Vina Muthmainnah, Nurul Aini as my best friend who always there and give a lot of joy to researcher
8. Stefanus Rafael Ihot Hutabarat as someone who is never tired of giving positive affirmations, support, and sincerity to researchers

9. Alya Nursabila and Aan Kurniawan as partners whom both struggled from start to finish to write this final project
10. Arum Nillam Ismudayani, Najmia Latifarani, and Trisdiyanti who always accompany the researcher in struggling to deal with all things related to lectures
11. All of my friends in President University especially in Industrial Engineering
12. All of the SEVENTEEN members, Choi Seungcheol, Yoon Jeonghan, Hong Jisoo, Wen Junhui, Kwon Soonyoung, Jeon Wonwoo, Lee Jihoon, Xu Minghao, Kim Mingyu, Lee Seokmin, Boo Seungkwan, Chwe Hansol, and Lee Chan, for the song and performance which always makes happy and keeps enthusiast to about completing this final project
13. For me, a great woman who always tries to be patient and stay strong until the end
14. For others who cannot be mentioned one by one, thank you for all the support and kindness that never runs out for researchers, thank you very much.

TABLE OF CONTENTS

PANEL OF EXAMINER APPROVAL	i
FINAL PROJECT ADVISOR RECOMMENDATION LETTER	ii
STATEMENT OF ORIGINALITY	iii
SCIENTIFIC PUBLICATION APPROVAL FOR ACADEMIC INTEREST	iv
ADVISOR APPROVAL FOR JOURNAL/INSTITUTION’S REPOSITORYv	
SIMILARITY CHECKING RESULT.....	vii
AI BASED PLAGIARISM CHECKING RESULT	viii
ABSTRACT	ix
ACKNOWLEDGMENT	x
TABLE OF CONTENT	xii
LIST OF FIGURES	xv
LIST OF TABLES	xvi
LIST OF TERMINOLOGIES	xx
CHAPTER I INTRODUCTION.....	1
1.1 Problem Background	1
1.2 Problem Statement	3
1.3 Objective.....	3
1.4 Scope and Limitation.....	3
1.5 Research Outline	3
CHAPTER II LITERATURE STUDY	5
2.1 Supply Chain Management	5
2.2 Decision-Making	6
2.3 Supplier Selection.....	8

2.4	Multi-Criteria Decision-Making (MCDM)	9
2.4.1	Analytical Hierarchy Process (AHP)	10
2.4.2	Ordinal Priority Approach (OPA).....	18
2.5	Previous Research	22
CHAPTER III RESEARCH METHODOLOGY		25
3.1	The General Flow of Research Methodology	25
3.2	Initial Observation and Problem Identification	26
3.3	Literature Study	26
3.4	Results and Analysis	26
3.5	Conclusion and Recommendation.....	32
CHAPTER IV RESULTS AND ANALYSIS.....		33
4.1	Objects of the Study	33
4.2	Criteria and Sub Criteria.....	33
4.2.1	Criteria and Sub Criteria Selection.....	33
4.2.2	Reliability Test for Criteria and Sub Criteria.	37
4.2.3	Modelling for the Analysis.....	41
4.3	Analytical Hierarchy Process (AHP)	42
4.3.1	Assessments and Results	42
4.3.2	Assessment Matrix and Synthesizing of the Matrix	48
4.3.3	Testing to the Consistencies of the Hierarchy.....	60
4.3.4	Local Weights, Global Weight and Preference Ranks.....	61
4.3.5	Determine Supplier Ranking for PROJECT #1 - Supply Lamp for GTN	63
4.3.6	Test to the Sensitivity of the Assessment Results	67
4.3.7	Supplier Ranking and Decision for PROJECT #1 – Supplying Lamps for GTN Building.....	69

4.3.8	Supplier Rankings and Decisions for PROJECT #2 - Pumps Supplying to Log Park.....	71
4.4	Ordinal Priority Approach Method	73
4.4.1	Prioritizing by Experts for Sub Criteria	74
4.4.2	OPA Solver	77
4.4.3	The Results of Global Ranking by OPA Method.....	78
4.5	Special Procedures for Exceptional Results	81
4.6	Summary for Selecting the Best Supplier for Projects	82
CHAPTER V CONCLUSION AND RECOMMENDATION		85
5.1	Conclusion.....	85
5.2	Recommendation.....	85
REFERENCES.....		87
APPENDIX.....		90

LIST OF FIGURES

Figure 2.1 A Simple Supply Chain	5
Figure 2.2 The Classic Approach to Decision-Making (Adair, 2010).....	7
Figure 2.3 The Three Levels of Hierarchy (Saaty et al., 2012)	11
Figure 2.4 Main Component of a Decision Making	18
Figure 3.1 The General Flow of Research Methodology.....	25
Figure 3.2 AHP Research Framework	28
Figure 3.3 OPA Research Framework	31
Figure 4.1 Common Modelling Used in This Research, for Selecting Best Supplier	42
Figure 4.2 Sample of Pairwise Scoring Result—Preference at Scale of 3.....	43
Figure 4.3 Sample of Pairwise Scoring Result—Preference at Scale of 6.....	44
Figure 4.4 Sample of Pairwise Scoring Result—Reversal Preference at Scale of 5	44
Figure 4.5 Sample of Aspect A is Preferable than Aspect B at 2 Scale.....	48
Figure 4.6 Sample of Aspect A is Preferable than Aspect B at 5 Scale.....	49
Figure 4.7 Chart of Supplier Preference for PROJECT #1	65
Figure 4.8 Chart of Supplier Preference for PROJECT #2.....	66
Figure 4.9 Input Data to OPA Solver for Expert-1 Data.....	77
Figure 4.10 Chart of OPA Results for Total Preference of Projects Suppliers.....	80

LIST OF TABLES

Table 2.1 Pairwise Comparison Scale (Saaty & Vargas, 2012).....	11
Table 2.2 The Example of Pairwise Comparison Matrix of Criteria	12
Table 2.3 The Example of Pairwise Comparison Matrix with Intensity Judgment	12
Table 2.4 Fraction Conversion and Column Addition	12
Table 2.5 Normalized Matrix for Criteria	13
Table 2.6 Calculation of Priorities: Row Averages	13
Table 2.7 Presentation of Result: Original Judgments and Priorities	14
Table 2.8 Consistency Indices for a Randomly Generated Matrix	15
Table 2.9 The Example of Preparation for Calculation of Model Synthesis	16
Table 2.10 The Example of Model Synthesis	17
Table 2.11 Sets, Parameters, and Variables of the OPA Method	20
Table 3.1 The List of Respondents	27
Table 3.2 Comparison Tables for Different Scenarios Sub Criteria Weight Calculation.....	29
Table 4.1 Projects under Analysis.....	33
Table 4.2 Criteria used in This Study, as used by PT SUA	34
Table 4.3 Dickson’s Supplier Selection Criteria.....	35
Table 4.4 Vasina’s Criteria and Sub Criteria for Supplier	36
Table 4.5 Cengiz’s Supplier Selection Criteria.....	36
Table 4.6 Cengiz’s Supplier Selection Criteria (Continued)	37
Table 4.7 Respondents Correlate to the Work	37
Table 4.8 Respondents Answer Result for Testing the Reliability	38
Table 4.9 Calculation of r Value for Correlation Test of Spec Conformity	39
Table 4.10 <i>r</i> table Value.....	39
Table 4.11 Table for Calculating r for the Reliability of the Chosen Sub Criteria	40
Table 4.12 Table for Calculating r for the Reliability of the Chosen Sub Criteria (Continued).....	41
Table 4.13 Sample Assessment Sheet.....	43

Table 4.14 Definition of Saaty (1987) Numeric Scaling	43
Table 4.15 Sample of Pairwise Scoring Rubric	45
Table 4.16 Sample of Absolute Scoring Rubric, cannot be used for AHP	45
Table 4.17 Sample of Assessment Sheet Scorings and Results	46
Table 4.18 Calculation of Geometric Mean.....	47
Table 4.19 Results of Pairwise Survey – Level #1 in CRITERIA.....	47
Table 4.20 Results of Pairwise Survey – Level #2 in PRICING	47
Table 4.21 Results of Pairwise Survey – Level #3 in PRICING of PROJECT #148	
Table 4.22 Sample of a Reciprocal Matrix for Assessing Aspect A and B, X from Two Opinions.....	49
Table 4.23 Sample of an Expected Reciprocal Matrix for Assessing Aspect A and B.....	49
Table 4.24 Sample of a Matrix for Assessing Aspect A and B by Arithmetic Mean – Cannot be Reciprocal	50
Table 4.25 Sample of a Matrix for Assessing Aspect A and B by Geometric Mean – Can be Reciprocal	50
Table 4.26 Saaty’s Scoring for Multi Correspondents and the Results by G Means	51
Table 4.27 Assessment Matrix - Cells Value Filling Up from Assessment Results	51
Table 4.28 Assessment Matrix of Level #1 Pairwise (between CRITERIA)	52
Table 4.29 Normalized Matrix and Preference Weight of Level #1 Pairwise (between CRITERIA)	53
Table 4.30 Reformed Matrix and Pref. Weight of Level #1 Pairwise (between CRITERIA).....	53
Table 4.31 RI Value for Numbers of Data.....	54
Table 4.32 CR Calculation Results for Level #1 Pairwise (between CRITERIA) 55	
Table 4.33 Sample of Survey Resulting $CR > 0.1$	55
Table 4.34 Weight of Preference for Sample Pairwise which Resulting $CR > 0.1$	56
Table 4.35 CR is Out of Limit $CR > 0.1$ for Sample Pairwise	56

Table 4.36 Re-Surveyed Assessment Results in Getting CR Value inside The Limit	57
Table 4.37 New Preference Weight of Re-surveyed Assessment Results	57
Table 4.38 Repaired Assessment Results in Getting CR Value inside the Limit .	57
Table 4.39 CR Summary Calculation for Level #1 Pairwise.....	58
Table 4.40 CI RI CR Summary Calculation for Level #2 Pairwise.....	58
Table 4.41 CI RI CR Summary Calculation for Level #2 Pairwise (Continued) .	59
Table 4.42 CI RI CR Summary Calculation for Level #3 Pairwise.....	59
Table 4.43 CI RI CR Summary Calculation for Level #3 Pairwise (Continued) .	60
Table 4.44 CIH RH CRH Calculation	61
Table 4.45 Weight, Local Weight, Global Weight	62
Table 4.46 Weight, Local Weight, Global Weight (Continued)	63
Table 4.47 Supplier Preference for PROJECT#1 in PRICING (Start of Table Series)	64
Table 4.48 Supplier Preference for PROJECT #1 in After Sales (End of Tables Series).....	64
Table 4.49 Supplier Preference for PROJECT #1	65
Table 4.50 Supplier Preference for PROJECT #2	66
Table 4.51 Different Weight of Sub Criteria in Different SCENARIO of PROJECT #1.....	69
Table 4.52 Sensitivity Test Results for PROJECT # 1 Respect to 3 Different Scenarios	70
Table 4.53 Sensitivity Test Results for PROJECT # 2 Respect to 3 Different Scenarios	71
Table 4.54 Sensitivity Test Results for PROJECT # 2 Respect to 3 Different Scenarios (Continued).....	72
Table 4.55 The Nature of OPA and AHP Become Alternatives Method for Selecting the Best Supplier	74
Table 4.56 Sub Criteria different Ranking by 5 Experts of OPA Method.....	74
Table 4.57 Sub Criteria different Ranking by 5 Experts of OPA Method (Continued)	75
Table 4.58 Supplier Ranking by 5 Experts of OPA Method Project #1	75

Table 4.59 Supplier Ranking by 5 Experts of OPA Method Project #2	76
Table 4.60 Supplier Ranking by 5 Experts of OPA Method Project #2	76
Table 4.61 Supplier Ranking by 5 Experts of OPA Method Project #2	77
Table 4.62 OPA Results for Experts Ranks—Expert Influence Rank.....	78
Table 4.63 OPA Results for Sub-Criteria Importance	78
Table 4.64 OPA Results for Sub-Criteria Importance (Continued).....	79
Table 4.65 OPA Results for Total Preference of Projects Suppliers	79
Table 4.66 Unlikelihood of Opposing Result between AHP and OPA	82
Table 4.67 Possible of Opposing Result between AHP and OPA	82
Table 4.68 Results Comparison between AHP and OPA Method.....	83

LIST OF TERMINOLOGIES

- Contractor : A person or business that accepts a contract to provide supplies or labor to complete a job
- Supplier : The entity in the form of an individual or organization that provides goods or services to other entities or also known the customer.
- Tender : The invitation to submit a bid a price, contract work, or supply goods for a project
- After-Sales Services : A process or effort made by a business to ensure customers are satisfied, either with the services or products offered
- r Test : Reliability Test for determining a proposed criteria which is under examination whether valid to become a liable criteria.
- r_{calculated} : The value of r, obtained by calculation to series of data.
- r_{table} : The value of r, provided at public scientific references
- i : Running number Index of matrix element at row i
- j : Running number Index of matrix element at column j
- [r_{ij}] : Reciprocal Matrix which elements are divided by unity value at diagonal, and all elements are inverse of the mirrored position elements to the unity diagonal.
- $$\begin{bmatrix} 1 & r_{12} & r_{13} \\ r_{21} & 1 & r_{23} \\ r_{31} & r_{32} & 1 \end{bmatrix}, \begin{bmatrix} 1 & r_{12} & r_{13} \\ 1/r_{12} & 1 & r_{23} \\ 1/r_{13} & 1/r_{23} & 1 \end{bmatrix}$$
- [a_{ij}] : Reciprocal Matrix which elements are result of pairwise
- [a_{ij}]_m : Matrix which elements of column are divided by the sum of elements at the respective columns. It is called as

Normalized Matrix. $\begin{bmatrix} r_{11}/\sum r_{i1} & r_{12}/\sum r_{i2} & r_{13}/\sum r_{i3} \\ r_{21}/\sum r_{i1} & r_{22}/\sum r_{i2} & r_{23}/\sum r_{i3} \\ r_{31}/\sum r_{i1} & r_{32}/\sum r_{i2} & r_{33}/\sum r_{i3} \end{bmatrix}$

$[W_{ij}]$: Column Matrix which elements are the preference weight of aspects
Det	: Eigen Vector, vector matrix which elements are the result of multiplication between elements of $[a_{ij}]$ and matrix of Weight $[M_{ij}]$
n	: Numbers of sample or data, Number of Criteria
λ_{\max}	: Principal Eigen Value, average value of Eigen Vector elements
CI	: Consistency Index, ratio between $(\lambda_{\max} - n)$ to $(n-1)$
RI	: Randomness Index, Great Abundance data Consistency Index for n numbers Criteria. The Value are provided by Saaty (1987) in a table. The table now available in public.
CR	: Consistency Ratio. The ratio between CI and RI. It describes the consistency of preference weighting (decision). The value must rely in $0 < CR < 0.1$ as Saaty (1987)