International Journal of Informatics and Information Systems ISSN 2579-7069
Vol. 5, No. 4, December 2022, pp. 156-166

Selection of Suppliers of Building Materials Using the Analytical Hierarchy Process (AHP) Method at PT. Cipta Nuansa Prima Tangerang

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(Received: September 8, 2022 Revised: November 10, 2022 Accepted: November 25, 2022, Available online: December 22, 2022)

Abstract

Supplier is one of the most important parts of a construction services provider company. PT. Nuance Prima Cipta Tangerang is a contracting company that offers construction services. Since the number of suppliers, PT. Nuance Prima Cipta Tangerang difficulty in choosing suppliers with their respective advantages. Therefore, use AHP (Analytical Hierarchy Process) for supplier selection process to make it more objective. Broadly speaking, AHP (Analytical Hierarchy Process) is the process of comparing criteria into alternatives, the greater the value is generated, then the main well to the supplier selected. By using the AHP method obtained the final value for each alternatif Lead A 39%, 12% and Supplier B Supplier C 49%.

Keywords: Supplier Selection; Methods Analytical Hierarchy Process; Decision Support System

1. Introduction

PT. Cipta Nuansa Prima Tangerang is a contractor company that offers construction services. Even though it is still a medium scale, PT. Cipta Nuansa Prima Tangerang has the competence to work on structural and architectural construction projects for commercial buildings on the island of Java. Having complete construction equipment, PT. Cipta Nuansa Prima Tangerang has completed many large projects spread across parts of the island of Java. The various types of projects at PT. Cipta Nuansa Prima Tangerang, of course, comes from the trust of consumers in the reputation of a company that is known to be reliable, by providing the best and most importantly, focusing on the timeliness that has been set to complete projects with high quality for customer satisfaction.

Currently PT. Cipta Nuansa Prima Tangerang has difficulty choosing the right supplier because judging is only based on the price offered and the quality of the goods subjectively (Wulandari, 2014), buying goods at the cheapest price per supplier so that the quality of the raw materials purchased is not good (Harsono, Prasetyo, & Arqom, 2009) resulted in complaints from customers (Hasdi, Sudarmaningtyas, & Supriyanto, 2014), requiring suppliers as providers of raw materials that regularly supply companies (Nurhalimah, 2015). Based on these problems, a Decision Support System (SPK) was developed using the Analytical Hierarchy Process (AHP) method for determining suppliers.

PT. Cipta Nuansa Prima Tangerang really understands that every consumer has specific needs and goals. Therefore, PT. Cipta Nuansa Prima Tangerang continues to strive to provide the best for its consumers. But to provide the best, PT. Cipta Nuansa Prima Tangerang also requires good quality building materials from its suppliers. Due to the large number of suppliers offering building raw material products, PT. Cipta Nuansa Prima has difficulty selecting suppliers (Wulandari, 2014) with their respective advantages. PT. Cipta Nuansa Prima Tangerang will not be good if its suppliers are unable to produce quality building materials or the delivery is not on time (Taufik, Sumantri, & Tantrika, 2014). Therefore, PT. Cipta Nuansa Prima needs to choose suppliers carefully.

2. Materials and Methods

2.1. Method of collecting data

Data collection techniques by observing, interviewing directly to the project manager, distributing questionnaires filled out by respondents consisting of commissioners, Project Manager Director and Project Engineering PT. Cipta Nuansa Prima Tangerang as well as conducting literature studies by reading books, journals that can support this research.

2.2. Analytical Hierarchy Process (AHP)

The AHP method developed by Thomas L. Saaty (Laksana, 2016) can solve complex problems where there are quite a lot of criteria taken (Siti, 2016), the structure of the problem is unclear (Viarani, Zadry 2016), uncertainty about the availability of accurate statistical data.

Kusrini (2007) suggests the procedures or steps in the AHP method include:

1) Define the problem and determine the desired solution, then arrange a hierarchy of the problems encountered. Setting the hierarchy is to set goals which are the overall system objectives at the top level.
2) Determines the priority of the elements
    a. The first step in determining the priority of elements is to make pair comparisons, namely comparing elements in pairs according to the given criteria
    b. The pairwise comparison matrix is filled using numbers to represent the relative importance of an element to other elements
3) Synthesis
   Synthesis The considerations for the pairwise comparisons are synthesized to obtain the overall priority. The things to do in this step are:
    a. Add up the values of each column in the matrix
    b. Dividing each value from the column by the total of the column in question to obtain matrix normalization
    c. Add up the values of each row and divide by the number of elements to get the average value
4) Measuring Consistency
   In making decisions, it is important to know how good the consistency is because we do not want decisions based on judgments with low consistency. The things to do in this step are:
    a. Multiply each value in the first column by the relative priority of the first element, the value in the second column by the relative priority of the second element, and so on
    b. Add up each row
    c. The result of the sum of the rows is divided by the corresponding relative priority element
    d. Add up the quotient above with the number of elements present, the result is called λ max 5. Calculate the Consistency Index (CI) with the formula:

       $$CI = (\lambda\, maks - n)/ - 1$$

       where n = the number of elements
5) Calculate the Consistency Ratio (CR) with the formula:
   $CR = CI\ /\ IR$
   where CR = Consistency Ratio
   $CI = Consistency\ Index$
   $IR = Indeks\ Random\ Consistency$
6) Checking the consistency of the hierarchy. If the value is more than 10%, then the judgment data assessor must be corrected. However, if the consistency ratio (CI/IR) is less than or equal to 0.1 then the calculation results can be declared correct. The list of Random Consistency Indexes (IR) can be seen in Table 1

Table. 1. List of random consistency indexes

Matrix Size	R Value
1,2	0.00
3	0.58
4	0.90
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49
11	1,51
12	1,48
13	1,56
14	1,57
15	1,59

2.3. Geometric Average

The weight of the assessment of several respondents in a group is averaged by the geometric mean of the assessment (Geometric Mean). The goal is to get a single value that represents a number of respondents. The geometric mean formula is as follows:

$G = \sqrt[n]{x1 \,.\, x2 \,.\, \ldots\ldots xn}$
$G = Rata - rata\ Geometrik$
$Xn = Rating\ ke\ 1, 2, 3, \ldots n$
$N = Number\ of\ Rating$

2.4. Scoring scale

The questions from the questionnaire which is a variable instrument in the AHP (Analytical Hierarchy Process) model are measured using a hierarchical rating scale with a nominal measurement scale value of 1-9 as in table 1 below:

Table. 2. Rating scale comparison of couples

Interest Intensity	Information
1	Both elements are equally important
3	One element is more important than the other elements
5	One element is more important than the other elements

7	One element is clearly more important than the other elements
8	One element is absolutely important than any other element
2,4,6,8	Values between two adjacent judgment values
Reverse	Reverse If activity i gets one numbers compared to activity j, then j has a value the opposite is compared with i

3. Results and Discussion

After defining the problem or problem, decomposition is carried out, namely breaking the whole problem into its elements. Done until no further solving is possible. Therefore, the process of analysis is called a hierarchy. The hierarchical structure consists of goals, criteria and alternatives. Goals or objectives in this hierarchy are SPK supplier selection, while the criteria consist of delivery, service, product, quality and price.

The alternatives consist of Supplier A, Supplier B and Supplier C. These criteria and alternatives were obtained from the results of interviews with the authorities at PT. Cipta Nuansa Prima Tangerang, the authorities in this research are the Commissioner, Director, Project Manager and Project Engineering who have provided their information regarding the criteria and alternative supplier selection at PT. Cipta Nuance Prima Tangerang. The following is the hierarchical structure of the Analytical Hierarchy Process (AHP) supplier selection decision support system, which can be seen in Figure 1

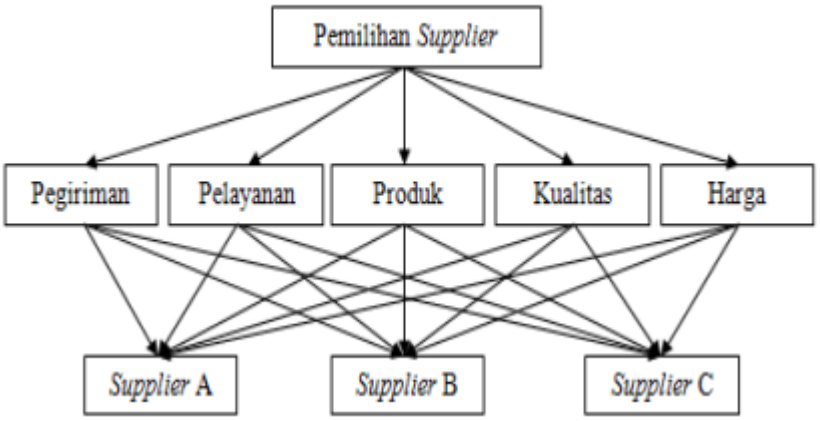

Figure. 1. AHP Hierarchical structure of supplier selection

3.1. Comparison Data Between Criteria

After the criteria are determined, weight is given to the relationship between the criteria and the criteria. The assessment was carried out by four experts at PT. Cipta Nuansa Prima Tangerang by filling out a questionnaire. After the results of each respondent's questionnaire are inputted into the expert choice, then the results of each respondent's questionnaire must be combined into a single data unit to continue AHP calculations using expert choice.

Table. 3. Pairwise comparison between criteria (Combined)

	Delivery	Service	Product	Quality	Price
Delivery		1,10668	2,91295	4,09062	6,08609
Service			1,76022	4,21287	6,2997
Product				1,91683	3,98428
Quality					2.0

Price	Incon :0,01				

airwise comparison geometric mean calculation Delivery-Service:

$$Geometric\ mean\ =\ \sqrt[n]{x_1 .\ x_2 .\ \ldots\ x_n}$$

$$= \sqrt[4]{3.3.\frac{1}{3}.\frac{1}{2}}$$

$$Combined\ results\ =\ 1.10668$$

Based on the geometric calculation results that have been calculated, the geometric average results are in accordance with the Expert Choice as shown in table 4 below:

Table. 4. Geometric calculations using Ms. Excel

Comparison Criteria	R1	R2	R3	R4	Average geometric
PGR - PLY	3	3	3	2	1,10668192
PGR - PDK	2	4	3	3	2,91295063
PGR - KLT	7	5	4	2	4,090623489
PGR - HRG	7	7	7	4	6,086092207
PLY - PDK	5	4	4	3	1,760223474
PLY - KLT	3	7	5	3	4,212865931
PLY - HRG	5	7	9	5	6,299703935
PDK - KLT	3	3	2	3	1,916829313
PDK - HRG	7	3	4	3	3,984282604

After the input of comparative data between criteria has been completed, it is entered into the Expert Choice, it will produce a normalization matrix between criteria which will determine the weight of each criterion.

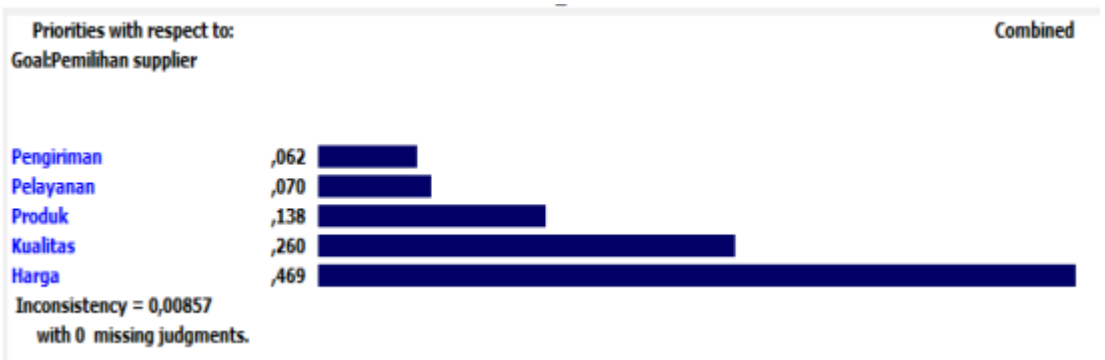

Figure. 2. Graph of matrix normalization between criteria

After getting the weight of the criteria (Priority vector) for each criterion. Then a data consistency check will be carried out to calculate the Consistency ratio (CR), λmax (Maximum Eigen) and Consistency Index (CI) are needed.

1) Determining the maximum Eigenvalue (λmax) Λmax is obtained by adding up all the multiplication results between the criteria weights (Vector Priority) and the number of Pairwise Comparison matrices. λmax = 5.05
2) Calculating the Consistency Index (CI) CI = 0.012
3) Calculating the Consistency Ratio (CR) CR = CI/IR, the IR value for n=5 is 1.12 (see table 1. Random Consistency Index List) CR = 0.01 => 0.01 (consistent)

Manual calculations have proven that the Expert Choice results in Figure 3 Graph of Normalized Matrix Between Criteria are correct.

3.2. Data Comparison of Assessment Alternatives Supplier Each Criteria

After determining and evaluating the criteria, then writing is also done for comparison of existing alternatives. Alternatives consisting of 3 suppliers are assessed based on these criteria. The following are the results of the 4 questionnaires that have been filled out by experts, combined and translated into a pairwise comparison matrix table using expert choice:

Table. 4. Pairwise comparison between criteria (combined)

	Supplier A	**Supplier B**	**Supplier C**
Supplier A		4,68069	1,13622
Supplier B			2,89251
Supplier C	Incon: 0,01		

After the input of comparative data between criteria has been entered into the Expert choice, it will produce a matrix normalization between alternatives which will determine the weight of each alternative based on the delivery criteria.

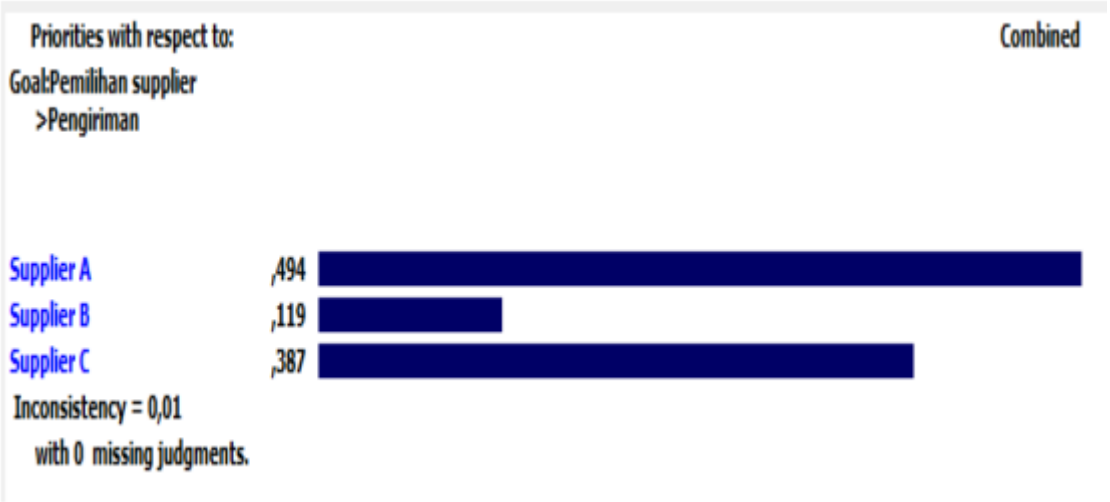

Figure. 3. Graph of matrix normalization between alternatives based on shipping criteria

3.3. Consistency Calculations

- Determining the maximum Eigenvalue (λmax) Λmax is obtained by adding up all the multiplication results between the criteria weights (Vector Priority) and the number of Pairwise Comparisson matrices. λmax = ((2,0938 x 0.4938)+(8,5732 x 0.1193)+(2,4819 x 0.3869)) = 3,017
- Calculating the Consistency Index (CI) CI = (3,017 - 3)/(3-1) = 0.009
- Calculating the Consistency Ratio (CR) CR = CI/IR, the IR value for n=3 is 0.58 (see table 1 List of Random Consistency Indices) CR = CI/IR = 0.009/0.58 = 0.015 => 0.01 (consistent)

Manual calculations have proven that the Expert Choice results in Figure 5 Graph Normalization Between Alternatives Based on Delivery Criteria are correct.

Table. 5. Pairwise comparison based on service criteria

	Supplier A	**Supplier B**	**Supplier C**
Supplier A		4,94923	3,56762
Supplier B			1,86121
Supplier C	Incon: 0,01		

After the input of comparative data between criteria has been entered into the Expert choice, it will produce a matrix normalization between alternatives which will determine the weight of each alternative based on service criteria.

Figure. 4. Graph of Matrix Normalization Between Alternatives based on service criteria

Consistency Calculation:

1) Determining the maximum Eigenvalue (λmax) Λmax is obtained by adding up all the multiplication results between the criteria weights (Vector Priority) and the number of Pairwise Comparisson matrices. λmax= ((1.4823 x 0.669)+(7.8104 x 0.1232)+(5.1049 x 0.2078)) = 3.015
2) Calculating the Consistency Index (CI) CI = (3.015 - 3) / (3-1) = 0.007
3) Calculating the Consistency Ratio (CR) CR = CI/IR, the IR value for n=3 is 0.58 (see table 1. List of Random Consistency Indices) CR = CI/IR = 0.007/0.58 = 0.013 => 0.01 (consistent)

Manual calculations have proven the Expert Choice results in Figure 8. Graph of Normalization Between Alternatives Based on Service Criteria is correct

Table. 6. Pairwise comparison based on product criteria

	Supplier A	**Supplier B**	**Supplier C**
Supplier A		2,91295	3,13017
Supplier B			5,59508
Supplier C	Incon: 0,03		

After the input of comparative data between criteria has been entered into the Expert Choice, it will produce a matrix normalization between alternatives which will determine the weight of each alternative based on product criteria

Figure. 5. Graph of matrix normalization between alternatives based on product criteria

Consistency Calculations

1) Determining the maximum Eigenvalue (λmax) Λmax is obtained by adding up all the multiplication results between the criteria weights (Vector Priority) and the number of Pairwise Comparisson matrices. λmax = 3.04
2) Calculating the Consistency Index (CI) CI = 0.02
3) Calculating the Consistency Ratio (CR) CR = CI/IR, the IR value for n=3 is 0.58 (see table 1. Random Consistency Index List) CR = 0.03 => 0.03 (consistent)

Manual calculations have proven that the Expert Choice results in Figure 11 Graph of Normalization Between Alternatives Based on Product Criteria are correct.

Table. 7. Pairwise comparison based on quality criteria

	Supplier A	**Supplier B**	**Supplier C**
Supplier A		1,51967	2,4323
Supplier B			4,78674
Supplier C	Incon: 0,01		

After the input of the comparative data between the criteria has been completed, it is entered into the Expert Choice, it will result in a matrix normalization between alternatives which will determine the weight of each alternative based on quality criteria.

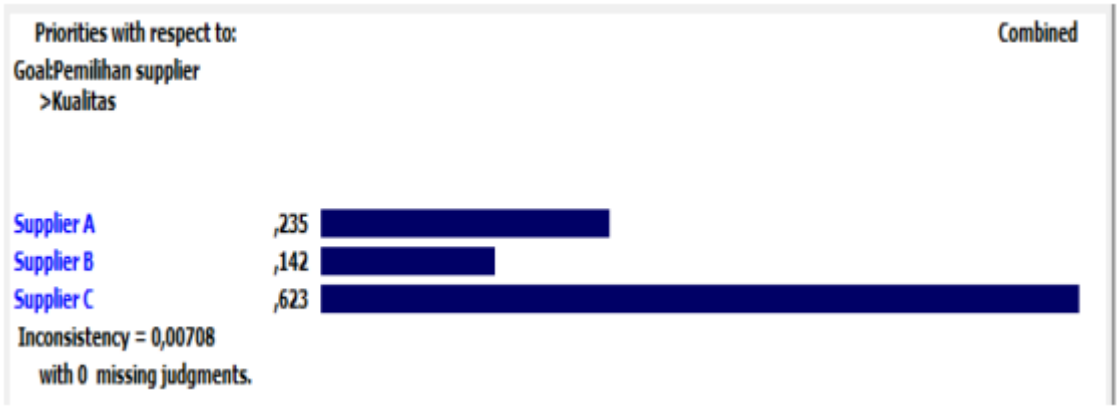

Figure. 6. Graph of matrix normalization between alternatives based on quality criteria

1) Determining the maximum Eigenvalue (λmax) Λmax is obtained by adding up all the multiplication results between the criteria weights (Vector Priority) and the number of Pairwise Comparisson matrices. λmax = ((4.0903 x 0.2354)+(7.3064 x 0.1422)+(1.6200 x 0.6223)) = 3.01
2) Calculating the Consistency Index (CI) CI = (3.01 - 3)/(3-1) = 0.01
3) Calculating the Consistency Ratio (CR) CR = CI/IR, the IR value for n=3 is 0.58 (see table II.2 List of Random Consistency Indices) CR = CI/IR = 0.01/0.58 = 0.01 => 0.01 (consistent)

Manual calculations have proven the results of Expert Choice in Figure IV.16 Graph of Normalization Between Alternatives Based on Quality Criteria is correct.

Table. 8. Pairwise comparison based on price criteria

	Supplier A	**Supplier B**	**Supplier C**
Supplier A		3,35037	1,22474
Supplier B			4,21287
Supplier C	Incon: 0,02		

After the input of comparative data between criteria has been entered into the Expert choice, it will produce a matrix normalization between alternatives which will determine the weight of each alternative based on the Price criteria.

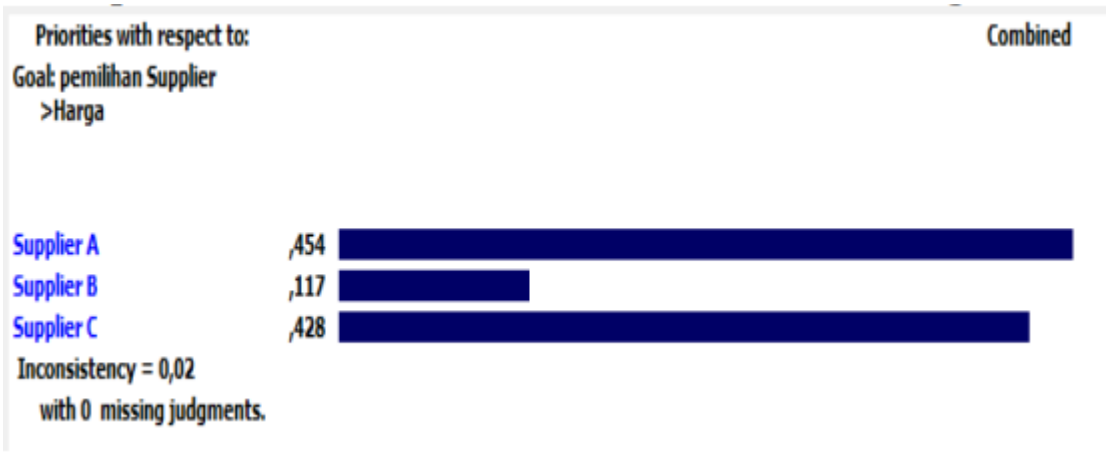

Figure. 7. Graph of matrix normalization between alternatives based on price criteria

Consistency Calculations:

1) Determining the maximum Eigenvalue (λmax) Λmax is obtained by adding up all the multiplication results between the criteria weights (Vector Priority) and the number of Pairwise Comparisson matrices. λmax = ((2.1150 x 0.4538)+(8.5633 x 0.1181)+(2.4621 x 0.4281)) = 3.03
2) Calculating the Consistency Index (CI) CI = (3.03 - 3)/(3-1) = 0.013
3) Calculating the Consistency Ratio (CR) CR = CI/IR, the IR value for n=3 is 0.58 (see table 1 Random Consistency Index List) CR = CI/IR = 0.013/0.58 = 0.02 (consistent)

Manual calculations have proven the Expert Choice results in Figure 17. The Normalization Chart Between Alternatives Based on Price Criteria is correct.

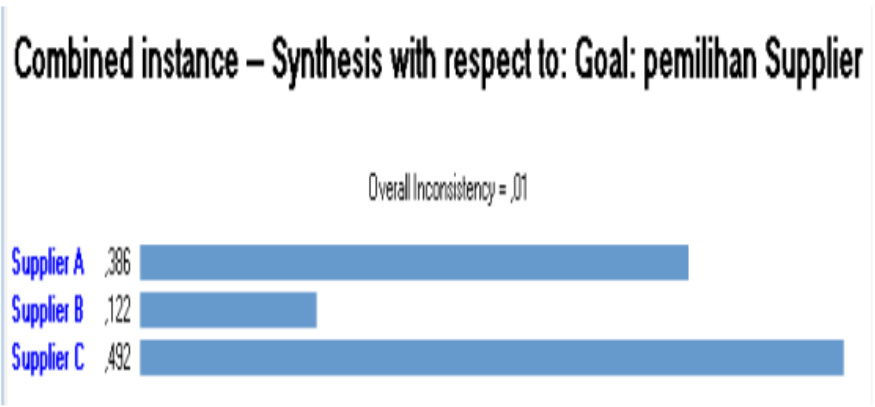

Figure. 8. Results of Synthesis With Respect

The picture above is the result of calculating the entire Analytical Hierachy Process for selecting majors using the Expert Choice application in graphical form.

The following is a graph and the final result of the calculation using Ms.Excel

Table. 9. Final results with Ms. Excel

GOAL	PRG	PLY	PDK	KLT	HRG	TOTAL
WEIGHT	6%	7%	14%	26%	47%	100%
Supplier A	0,030987	0,047089	0,034441	0,061329	0,212084	39%
Supplier B	0,007488	0,008671	0,01396	0,037053	0,055192	12%
Supplier C	0,024279	0,014622	0,090634	0,200039	0,200039	49%
						100%

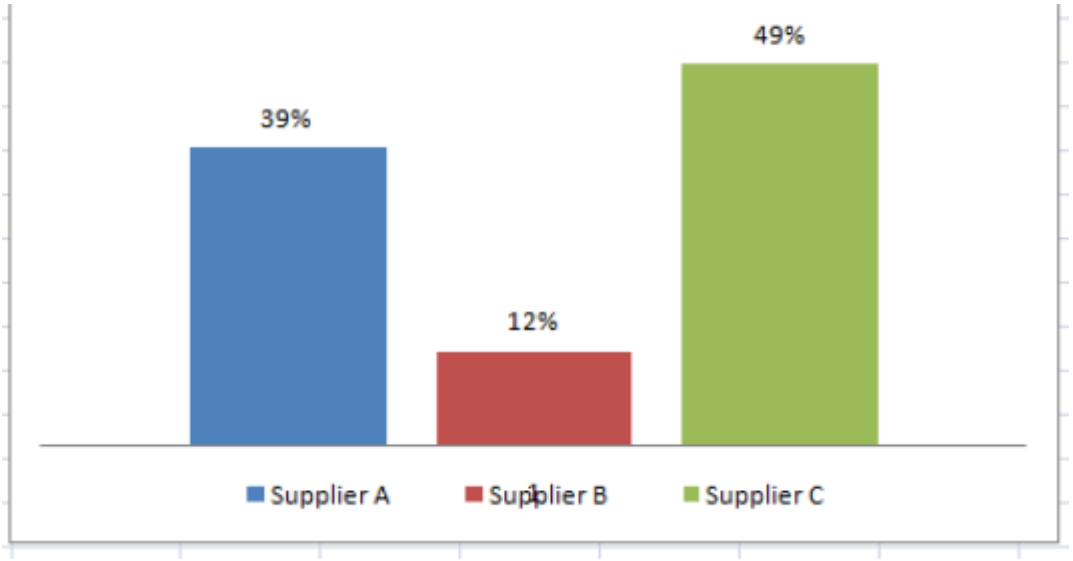

Figure. 9. Graph of Final Assessment of Supplier Selection

4. Conclusion

Based on data processing and analysis that has been carried out by the author, the following conclusions can be drawn:

1) The results of the analysis from the calculation of the Analytical Hierarchy Process stated that the alternative that was selected and best suited to the criteria was Supplier C. With the AHP calculation obtained from 4 respondents who gave their answers it was calculated and the final score was that Supplier C was superior by 49% compared to Supplier A39% and also Supplier B 12%.
2) The main factor that is most prioritized in supplier selection is price with a weight value of 0.469 or 46.9%. and the most prioritized Supplier is Supplier C with a weighting value of 49%.
3) The Analytical Hierarchy Process method can help companies especially to determine supplier selection using Expert Choice tools and Ms. Excel. inconsistency.
4) This research is related to the needs of PT. Cipta Nuansa Prima Tangerang at this time, so for different times, conditions and places it is necessary to carry out further research. The decision support system created can be further developed using other methods such as the Simple Additive Weighting (SAW), Fuzzy or Profile Matching methods as research for even better results.

References

[1] Handayani, I. & Darmianti, Y. (2015). Laporan Akhir Penelitian Mandiri. Jakarta: AMIK BSI Jakarta

[2] Hasdi, R. F., Sudarmaningtyas, P., & Supriyanto, A. (2014). Rancang Bangun Sistem Pendukung Keputusan Pemilihan Supplier Pada Derry Auto Service Dengan Metode Ahp. JSIKA, 90-96.

[3] Harsono, A., Prassetyo, H., & Arqom, N. (2009). Metode Pemilihan Pemasok Sayuran di Supermarket dengan Metode AHP dan PROMETHEE. Jurnal Itenas Rekayasa, 13(4).

[4] Kusrini. (2007). Konsep dan Aplikasi Sistem pendukung Keputusan. Yogyakarta: Andi Offset.

[5] Laksana, T. G. (2016). Sistem Pendukung Keputusan Seleksi Supplier Pemilihan Bibit Ayam Broiler Menggunakan Metode Ahp (Study Kasus: CV. CMB). JURNAL ICT, 13(1).

[6] Nurhalimah. (2015). Sistem Pendukung Keputusan Pemilihan Supplier Bahan Baku Konveksi Dengan Metode AHP (Studi Kasus: Alta Moda Convection Medan). Majalah Ilmiah Informasi dan Teknologi Ilmiah (INTI), 129-136.

[7] Siti, F. (2016). Sistem Pendukung Keputusan Seleksi Siswa-Siswi Berprestasi dari Keluarga Miskin dengan Metode AHP di SMA Negeri 14 Semarang. Skripsi, Fakultas Ilmu Komputer.

[8] Taufik, R., Sumantri, Y., & Tantrika, C. F. M. (2014). Penerapan Pemilihan Supplier Bahan Baku Ready Mix Berdasarkan Integrasi Metode AHP Dan Topsis (Studi Kasus Pada PT Merak Jaya Beton, Malang). Jurnal Rekayasa dan Manajemen Sistem Industri, 2(5), p1067-1076.

[9] Viarani, S. O., & Zadry, H. R. (2016). Analisis Pemilihan Pemasok dengan Metode Analitycal Hierarchy Process di Proyek Indarung VI PT Semen Padang. Jurnal Optimasi Sistem Industri, 14(1).

[10] Wulandari, N. (2014). Perancangan Sistem Pendukung Keputusan Pemilihan Supplier di PT. Alfindo Dengan Metode Analytical Hierarchy Process. Jurnal Sistem Informasi, 4-7.