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THE RIGHT CRITERIA IN SELECTING THE SUPPLIER OF LOTTO FABRIC RAW MATERIAL IN CONVECTION INDUSTRY BY USING AHP AND TOPSIS METHODS

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ABSTRACT

Family Sport Clothing convection is Mr. Raharjo's family business in textile industry which produces training pants, made of lotto fabric. The company only has one criterion in supplier selection process, and in this convection is the cost. In this convection, problems that usually occur in selecting the supplier of raw materials are the production process is delayed since the raw materials are not enough; the quality of the raw materials does not meet the company standards; and supplier that does not deliver on time. This study was conducted with the aim of identifying the criteria used in selecting supplier and determining the ranking or the best supplier priority. The researcher implemented AHP (Analytical Hierarchy Process) method by distributing questionnaires to the owners of convection, and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) by measuring the shortest distance between positive ideal solutions and the longest distance with negative ideal solutions. The criteria were adopted from previous researches, and processed by using Pareto diagrams. Based on the results of calculations using Pareto diagram, the criteria used in this study are quality, cost, service, delivery, feasibility, and capacity. Based on the results of calculation using AHP method, the order of the most prioritized criteria is: quality (0.37), cost (0.29), capacity (0.13), feasibility (0.12), delivery process, (0.07,) and service (0.03). In addition, the priority order of the suppliers based on TOPSIS is: Libeng Kiantana (0.45), Yudi Hartono (0.23), Abdul Ghofur (0.23), Panorama Shop (0.06) and Indigenous Face Shop (0.02).

Keywords: Criteria, Supplier, Raw Material, Analytical Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

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1. INTRODUCTION

Indonesia belongs to a developed country, and the economy of Indonesia is influenced by manufacture and service industries. As the development of the era, the competitiveness in industrial world is getting higher, especially in manufacture industry. One of the strategies that should be implemented is by improving the productivity of the manufacture industry, by supervising the availability of raw material from the supplier, in order to support the production process.

The previous studies in identifying the supplier selection procedure had been conducted and published, such as Shinta (2017) and Dewie (2019). Based on the results of these studies, cost is the most important criterion in selecting the supplier, in order to improve the productivity [2] [10]. Meanwhile, according to Priti (2013), selecting a right supplier is a complex problem, and this problem usually happens in an industry. Thus, when problem occurs, for example in financial aspect, it can be anticipated by choosing the right supplier, in order to increase the industry's income [6]. On the other hand, Armandina's (2016), Putri's (2017), and Yusuf's (2020) studies revealed that quality is the most important criterion, since in selecting supplier, cost is not always critical, and there are other important criteria that should be considered [1] [7] [15].

In Family Sport Clothing, the owner only has one criterion in selecting the supplier, and in this convection is the cost. According to Raharjo, the owner of Family Sport Clothing, the convection has been developed for 25 years, and the low price from the supplier can decrease the production cost. In other words, the low cost will give positive impact on increasing the industry's income. On the other hand, the reality is it has negative impact on the production process, since the raw materials are not enough, the quality of the raw material does not meet the company standards, and supplier that does not deliver on time. Based on these problems, an evaluation is needed in order to make assessment on the supplier. The assessment can be used as the standard in determining the priority of the supplier, and it can be used to determine the criteria in supplier selection process.

By choosing a right supplier, it can bring a positive change for the industry, since the better the supplier, the higher the production. Thus, every industry has their own criteria in selecting the right supplier. Qualitative and quantitative criteria can be used in making decisions in the supplier selection process. Therefore, an appropriate method is needed in selecting the supplier, in order to be able to decide effectively and efficiently, such as AHP (*Analytical Hierarchy Process)* and TOPSIS (*Technique for Order Preference by Similarity to Ideal Solution*) methods.

1. Materials and Methods

The Method of Collecting the Secondary Data

The secondary data were collected by applying literature study. Literature study was applied by reading some references in order to comprehend the concepts and theories related to the research problems. According to 13 (thirteen) previous studies, [1] [2] [3] [4] [5] [6] [7] [8] [10] [13] [14] [15] [16], the criteria used in those studies were classified based on the scope, such as had same definitions and presented in Pareto diagram, in order to identify the most used criteria.

Table 1. Data of Frequency in Each Criterion

No	Classification	Criterion	Total Number
1	Quality, product quality level, product quality, specification of raw material.	Quality	14
2	Cost: price, pricing, financial position, financial.	Cost	14
3	Service: relationship, warranty, attitude supplier strategic alliance, service capability, quality of relationship, communication system.	Service	14
4	Delivery: the, time, punctuality, delivery reliability, on time delivery.	Delivery	12
5	Management, management system, green image, green competencies, environment management system, manufacturing capability.	Feasibility	6

6	Quantity, technical capacity, inventory availability, improvement capacity, production capacity	Capacity	5
7	Environmental performance, pollution rate of the raw material, pollution control.	Environmental performance	3
8	Logistic position, geographical location	Location	2
9	Flexibility: flexibility and responsiveness	Flexibility	2
10	Reliability, operating control.	Reliability	2
11	Brand name, performance history.	Brand	2
12	Technological competence	Technology	1
	Total		**77**

According to Saputra (2018), determination of the criteria can be done by collecting the previous criteria used in previous researches, which had been classified based on

the same scope, and processed with Pareto principle [9]. In determining the criteria, Pareto diagram is used in order to make the readers easier in reading the data. Konch in Sunarto (2020) stated that in Pareto principle, in most cases, 80% impacts are caused by 20% factors [11]. Based on the result of the study, the Pareto Diagram is as follows:

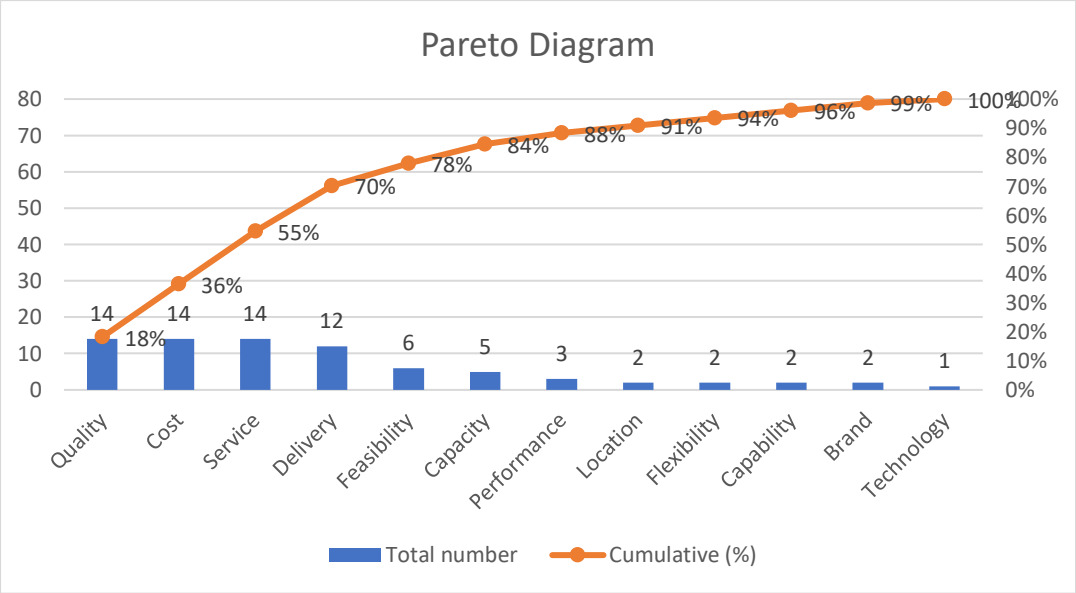


Figure 1. Pareto Diagram

Based on Figure 1. It indicated that there are 6 (six) criteria used in the study, such as quality, cost, service, delivery, feasibility, and capacity, as much as 84%.

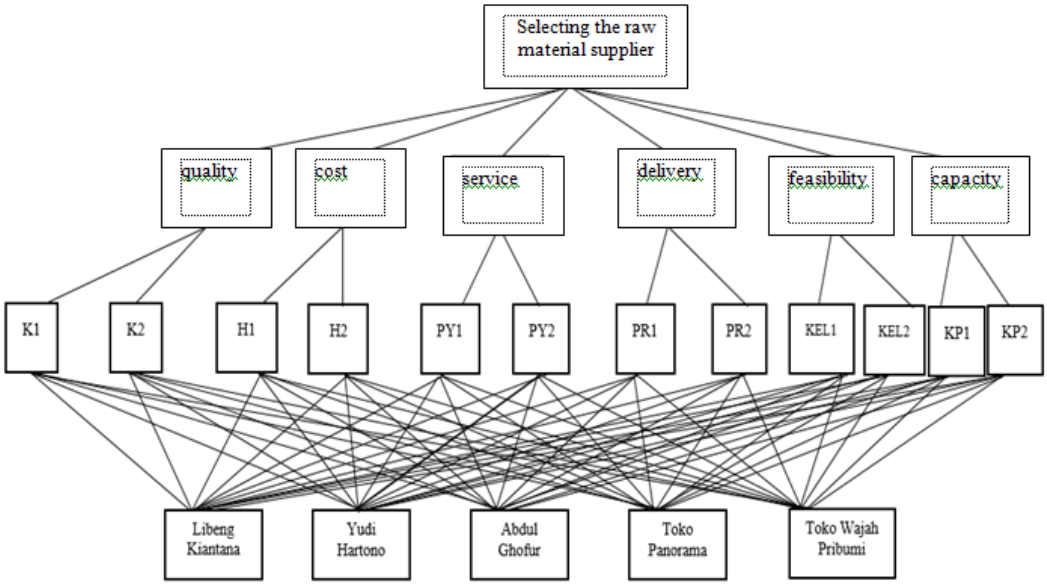
The Method of Collecting Primary Data

The primary data were collected by implementing several observations and interviews, and distributing questionnaire. The interviewees were the owners of the convection, and the interview was not conducted structurally. In other words, there was no sequence of the questions. The interview was conducted with the aim of obtaining the data of sub-criteria and alternative of the owner's trusted supplier in the research process. Hence, the hierarchical structure is formed as follows:

1. K1 : THE QUALITY LEVEL OF THE RAW MATERIAL
2. K2 : THE CONSISTENCY OF THE QUALITY
3. H1 : THE PRICE OF THE RAW MATERIAL
4. H2 : THE DELIVERY COST OF RAW MATERIAL
5. PY1 : THE COMMUNICATION EASEMENT
6. PY2 : THE SERVICE OR THE ATTITUDE OF THE SUPPLIER
7. PR1 : THE PUNCTUALITY OF THE SUPPLIER

8. PR2 : THE ACCURACY OF THE TOTAL NUMBER OF RAW MATERIAL
9. KEL1 : THE PERFORMANCE IN PREVIOUS TIME
10. KEL2 : THE PAYMENT SYSTEM
11. KP1 : THE CAPACITY IN THE AVAILABILITY OF RAW MATERIAL

KP2 : The availability of raw material



12. FIGURE 2.THE HIERARCHICAL STRUCTURE IN AHP

The questionnaire was distributed with the aim of identifying the weight of each criterion used in processing data related to the company assessment toward the supplier. The questionnaire was distributed to Mr. Raharjo and Ms. Nuzul Vita as the owners of Family Sport Clothing. Saaty in Zulhadi (2017) stated that by implementing AHP, the quality of the data obtained from the respondents are not depend on the quantity, but on the minimum limitation, such as the respondents [16]. The questionnaire distributed to the respondents consisted of pairwise comparisons questions for each criterion, sub-criterion, and the alternative, answered by placing a check mark (√) in the columns, by using a pairwise comparison scale, based on the condition in the company.

Data Processing in AHP Method

AHP method is intended to obtain the weight of pairwise comparison in each criterion, sub-criterion, and alternative. In addition, Analytical Hierarchy Process (AHP) is intended to arrange the alternative for solving the problems, while the main input is the field expert, in order to identify the supplier performance based on the weight of criteria, sub-criteria, and alternative. The steps of AHP are as follows:

1. Define the Problem

This research was conducted with the aim of selecting the best supplier, by determining several criteria. The determination of the criteria was done by conducting interviews with the stakeholders in the company. After that, the interview results were analyzed in order to identify the feasibility of the previous criteria by using Pareto diagram, and the data were obtained from the previous studies.

2. Organize the Problem as A Hierarchical Structure

The hierarchical structure was formed with the highest level as the main objective, followed by the criteria, sub-criteria, and alternative in the latest position, as shown in Figure 2.

3. Construct A Pairwise Comparison Matrix

Pairwise comparison matrix was made based on the hierarchical structure, starting from comparing each criterion, comparing the sub-criteria, and comparing the alternatives. The pairwise comparison scale and its meaning can be identified based on rating of the intensity of importance proposed by Thomas L. Saaty:

1 equal importance
3 suppliers slightly favor one element over another
5 suppliers slightly favor one element over another
7 suppliers very strongly favor one element over another
9 suppliers strongly favor one element over another
2,4,6,8 value compromise between two assessment / close.

4. Normalize the Data.
   This step was conducted with the aim of obtaining a decision matrix with the same value range on each criterion.
5. Calculate the Eigenvectors
6. Conduct A Consistency Test
   .

In calculating the consistency ratio value, the consistency is indicated by the consistency index. If CI = 0 then it is consistent, if CR <0.1 then it is sufficiently consistent, and if CR> 0.1 then it is very inconsistent, and the assessment must be remediated.

$$CR = \frac{CI}{CR_n} \quad \text{.....(1)}$$

Explanations:
CR = consistency ratio
CI = consistency index
RI = random index
The random index (RI) value depends on the number of the criteria (n), as shown in Table 2

Table 2. Random Index (RI)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.9	1.2	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

Source: Saaty in Zulhadi, 2017 [16].

Data Processing in TOPSIS Method

In TOPSIS, the selected alternative is considered as the best alternative which has the shortest distance from positive-ideal solution (A +), and the longest distance from negative-ideal solution (A-). The steps of TOPSIS are as follows:

1. Construct the Normalized Decision Matrix
   Constructing performance ratings of each alternative in normalized criteria, in order to form a decision matrix with the same range of values on each criterion.
2. Construct the Weighted Normalized Decision Matrix
   The total weight value of the alternative is multiplied by the weight value of each sub-criterion, presented in the form like a decision matrix.
3. Determine positive-ideal solution matrix and negative-ideal solution matrix
   Positive-ideal solution matrix is a matrix that is determined by selecting the maximum value of the criteria, while negative-ideal solution matrix is the opposite.
4. Calculate the Separation Measure of Each Alternative (with positive and negative ideal solution matrices)
   In determining the distance between each alternative, positive-ideal solution matrix aims to measure the distance of each alternative from positive-ideal solution. The closer the distance, the better the alternative value.
5. Rank the Alternatives
   The ranking is based on the preference value obtained from the result of the calculation by using TOPSIS. By ranking the alternatives, it can help the company in choosing the alternative supplier.

2. Result and Discussions

The first step conducted in this study was collecting the data of criteria used in several previous studies, which were classified based on the same meaning (Table 1.). Then, the data of frequency of each criterion were processed by using Pareto diagram (Figure 1.), as much as 80% of the data. Furthermore, 6 criteria were obtained, such as quality, price, service, delivery, feasibility, and capacity. The information related to the determination of sub-criteria for each criterion and alternative / supplier used in the company was obtained during the interview with Mr. Raharjo and Ms. NuzulVilta Sari as the owners of Family Sport Clothing, and the results indicated that there are 12 sub-criteria and 5 alternatives / suppliers used in this study, as shown in Figure 2.

After collecting and processing the data, it can be concluded that the highest weight of the alternatives, sub-criteria, and criteria affect the assessment in the selection of raw material supplier.

Table 3. The Weight of Each Criterion

No	The Criterion in Selecting the Supplier of Lotto Fabric Raw Material	Weight
1	Quality	0.36
2	Cost	0.29
3	Capacity	0.13
4	Feasibility	0.12
5	Delivery	0.07
6	Service	0.03
	Total	**1.00**

Based on the result of data processing, it indicates that the consistency level of the weights comparison in each criterion is 0.084, so the value is considered as sufficiently consistent and accepted, since the consistency level is less than 0.1. The weight-comparison value of each criterion can be seen in Table 3. Based on Tabe 3., quality criterion is in the first rank since it has the largest weight compared to the other criteria, as much as 37% (0.37). In other words, Family Sport Clothing convection focuses more on the quality level in choosing suppliers. High quality material is critical since it will affect the quality of the products. Meanwhile, cost criterion is in the second rank, as much as 29% (0.29), which means that Family Sport Clothing convection considers the cost / price of the raw materials in selecting the supplier that will become the priority. The price has an impact on the company profit or the target, since it can save the money. Capacity criterion is in the third rank, as much as 13% (0.13), which will be a priority in selecting the supplier in Family Sport Clothing convection. Hence, the availability of raw materials at the supplier is also considered since it will affect the supply of raw materials. Feasibility criterion is in the fourth rank, as much as 11% (0.11), which means that an eligible supplier that has a good record can be considered to make cooperation with the company. Meanwhile, delivery criterion is in fifth rank, as much as 5% (0.07), and service is in the last rank (3% (0.03)).

Table 4. The Weight of Sub-Criteria

No.	Sub-criteria	Weight
1	K1	0.50
2	K2	0.50
3	H1	0.87
4	H2	0.13
5	PY1	0.76
6	PY2	0.24
7	PR1	0.31
8	PR2	0.69
9	KEL1	0.74
10	KEL2	0.26
11	KP1	0.63
12	KP2	0.37

Based on Table 4, quality criterion has two sub-criteria, such as the quality level of raw material (K1) and quality consistency (K2), while assessment weighting and consistency test had been conducted. In addition, based on the results of data processing, the consistency level of weight comparison between the sub-criteria of quality criterion is 0, and it is categorized as consistent and accepted, since the consistency level of the sub-criteria is less than 0.1. The weight-comparison value of each criterion can be seen in Table 4. Based on Table 4, neither K1 nor K2 are more dominant in the sub-criteria of quality criterion, indicating that Family Sport Clothing convection considers both quality level of raw materials and the quality consistency in selecting a supplier. In other words, the quality level of raw materials and quality consistency in providing good raw materials are very influential in the production process. As a result, both sub-criteria are considered as equally important.

Meanwhile, cost criterion has two sub-criteria, such as the cost of raw materials (H1) and the delivery charges on raw material cost (H2) while

assessment weighting and consistency test had been conducted. Based on Table 4, the consistency level of weight comparison between the sub-criteria of price criterion is 0, and it is categorized as consistent and accepted, since the consistency level of the sub-criteria is less than 0.1. Based on Table 4, H1 is more dominant than H2. In other words, Family Sport Clothing convection tends to emphasize the price of raw materials rather than the delivery cost. The low price of raw material is prioritized since it is considered as the most influential factor for the cost savings in the production process and the profit, rather than the delivery cost

Service criterion has two sub-criteria, such as communication easement (PY1) and supplier's service / attitude (PY2), while assessment weighting and consistency test had been conducted. Based on Table 4, the consistency level of the weight comparison between the sub-criteria of service criterion is 0, and it is categorized as consistent and accepted, since the consistency level is less than 0.1. Based on Table 4. it can be concluded that communication easement is more prioritized since supplier's effort in making the communication easier is necessary, such as giving good responses when customer wants to order raw materials, which is more critical than supplier's attitude / service sub-criterion.

Delivery criterion has two sub-criteria, such as the accuracy of delivery time (PR1) and the accuracy of the quantity of raw materials (PR2), while assessment weighting and consistency test had been conducted. Based on Table 4, the consistency level in weight comparison between the sub-criteria of delivery criterion is 0, and it is categorized as consistent and accepted, since the consistency level is less than 0.1. Based on Table 4, the accuracy of the quantity of raw materials is more prioritized since it has a direct impact on the number of products, rather than the accuracy of delivery time sub-criterion.

Feasibility criterion has two sub-criteria, such as payment system (KEL1) and previous performance (KEL2), while assessment weighting and consistency test had been conducted. Based on Table 4, the consistency level of weight comparison between the sub-criteria of feasibility criterion is 0, and it is categorized as consistent and accepted, since the consistency level is less than 0.1. Based on Table 4, it indicates that the previous performance is prioritized since the previous assessment toward the quality of the supplier can be a guarantee for the company, rather than the payment process.

Capacity criterion has two sub-criteria, such as the capacity of the quantity of raw materials (KP1) and the availability of raw materials (KP2), while assessment weighting and consistency test had been conducted. Based on Table 4, the consistency level of weight comparison between the sub-criteria of capacity criterion is 0, and it is categorized as consistent and accepted, since the consistency level is less than 0.1. Based on Table 4, it indicates that the capacity of the quantity of raw materials is prioritized since it is considered as the supplier's capacity to adjust the quantity fluctuation based on the company's expectation, and it is more important than the availability of raw materials.

Table 5. The Weight of Alternative in Each Sub-Criterion

Criterion	Sub-criterion	Libeng Kiantana	Yudi Hartono	Abdul Ghofur	Toko Panorama	Toko Wajah Pribumi
K	K1	0.32	0.07	0.42	0.09	0.10
	K2	0.38	0.11	0.33	0.09	0.09
H	H1	0.47	0.33	0.10	0.06	0.04
	H2	0.11	0.09	0.42	0.21	0.18
PY	PY1	0.08	0.25	0.26	0.30	0.11
	PY2	0.06	0.20	0.27	0.34	0.13
PR	PR1	0.23	0.22	0.14	0.15	0.27
	PR2	0.31	0.39	0.10	0.08	0.13
KEL	KEL1	0.32	0.35	0.09	0.08	0.16
	KEL2	0.11	0.37	0.24	0.20	0.08
KP	KP1	0.33	0.24	0.15	0.19	0.09
	KP2	0.42	0.20	0.19	0.13	0.07

Based on Table 5, Libeng Kiantana's weight value is higher in cost criterion and H1 sub-criteria (0.47), namely the price of raw materials. Meanwhile, Yudi Hartono's weight value is higher in delivery criterion and PR2 (0.39), namely the accuracy of the quantity of raw materials. On the other hand, Abdul Ghofur's weight value is higher in quality criterion and K1 (0.42), namely the level of quality of raw materials in cost criterion (H2) (0.42), such as the cost of delivering raw materials. Toko Panorama's weight value is higher in the service criterion and PY2 sub-criteria (0.34),

namely the supplier's service / attitude. Meanwhile, Toko Wajah Pribumi's weight value is higher in the delivery criterion and PR1 (0.27), namely the delivery time.

Table 6. Weight of Supplier with AHP

Supplier	Weight	Percentage	Ranking
Libeng Kiantana	0.35	35%	1
Yudi Hartono	0.22	22%	3
Abdul Ghofur	0.23	23%	2
Toko Panorama	0.11	11%	4
Toko Wajah Pribumi	0.09	9%	5
Total	**1**	**100%**	

Based on the results of data processing, the final weight value of each supplier by using AHP indicates that Libeng Kiantana is in the first rank, with a weight of 0.35, based on the questionnaire results filled by the owners of the convection. Meanwhile, Abdul Ghofur is in the second rank, with a weight of 0.23, followed by Yudi Hartono with a weight of 0.22, Toko Panorama with a weight of 0.11, and the last is Toko Wajah Pribumi with a weight of 0.09.

The result of data processing by using AHP method depends on the respondents / the field experts, and they are Mr. Raharjo and Mrs. Nuzul, the owners of Family Sport Clothing convection. Since the data processing is not only based on subjective assessments, it requires the Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) method in order to obtain a result that is based on the best alternative, such as having the shortest distance from the positive-ideal solution (maximizes the benefit and minimizes the cost criteria), and having the longest distance from the negative-ideal solution (maximizes the cost and minimizes the benefit criteria), and they can recommend the best supplier as expected. The results of AHP data processing is in the form of final weight of each alternative, and it is used for data processing using Technique of Order Preference by Similarity to Ideal Solution (TOPSIS) method, by remediating the ranking process in order to propose the priority of the supplier.

Table 7. The Recapitulation of the Supplier Ranking by using TOPSIS

Supplier	D^+	D^-	C	Weight	Percentage	Ranking
Libeng Kiantana	0.09	0.33	0.79	0.45	45.21%	1
Yudi Hartono	0.23	0.17	0.42	0.24	23.89%	2
Abdul Ghofur	0.25	0.17	0.40	0.23	22.94%	3
Toko Panorama	0.34	0.04	0.10	0.06	5.94%	4
TokoWajah Pribumi	0.35	0.01	0.04	0.02	2.02%	5
Total			**1.75**	**1**	**100%**	

The summary of the supplier ranking is based on the results of data processing by using AHP and TOPSIS methods, as shown in Table 6. It indicates that Libeng Kiantana Supplier has the shortest distance from positive-ideal solution, as much as 0.09, and has the longest distance from negative-ideal solution, as much as is 0.33, and it has greater significance value of 45,21. Meanwhile, Yudi Hartono (0.24) is in the second rank, Abdul Ghofur (0.23) is in the third rank, Toko Panorama (0.06) is in the fourth rank, and Toko Wajah Pribumi (0.02) is in the fifth rank.

Based on Table 7, Libeng Kiantana is the most suitable supplier who meets the requirements of lotto fabrics raw material, according to the criteria determined by Family Sport Clothing convection. The concept of TOPSIS method is by selecting the alternative, such as the one that has the shortest distance from positive-ideal solution (D +), and has the longest distance from negative-ideal solution (D-). A positive ideal solution is defined as the sum of the best values or the maximum benefit that can be achieved while minimizing the costs. Meanwhile, a negative-ideal solution consists of the worst values, which maximizes the cost criterion and minimizes the benefit criterion. The supplier who meets these requirements is Libeng Kiantana, based on the result of data processing by using TOPSIS method.

3. conclusion

Based on the results of data processing and data analysis by involving 5 alternatives / suppliers, there are 6 main criteria and 12 sub-criteria in selecting the supplier of lotto fabrics raw materials in Family Sport Clothing Convection. Therefore, it can be concluded that:

1. The criteria determined in selecting the supplier of lotto fabric raw materials in Family Sport Clothing convection are quality, price, service, delivery, feasibility, and capacity, as much as 84% in Pareto diagram. Meanwhile, 12 sub-criteria are obtained during the interview with the owners of the convection. The 12 sub-criteria are: the level of quality of raw materials, quality consistency, price of raw materials, cost of delivery of raw materials, communication easement, supplier's service / attitude, the punctuality of delivery, accuracy of the quantity of raw materials, previous performance, payment system, capacity, and the availability of raw materials. Alternative data / suppliers in this study consisted of 5 suppliers, namely Libeng Kiantana, Yudi Hartono, Abdul Ghofur, Toko Panorama, and Toko WajahPribumi, while the data were obtained during the interviews with the owners of the Convection.
2. The result of AHP and TOPSIS methods indicate that Libeng Kiantan is the best supplier based on the rank, with an alternative preference value of 45.21% (0.45). while Yudi Hartono's preference value is 23.89% (0.23) or in the second rank, Abdul Ghofur's preference values is 22.94% (0.23) or in the third rank, Panorama Shop preference value is 5.94% (0.06) or in the fourth rank, and Toko Wajah Pribumi is in the last rank, as much as 2.02% (0.02).

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