The Determination of Yarn Supplier by Using the Weight Product Method

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Abstract. The Upstream Supply Chain Management is the initial component of the supply chain where the company gets raw materials from suppliers for the production process. This process is very important in the sustainability of a company's production. The obstacle experienced at this stage is how the company decides which suppliers to choose from the many suppliers who want to offer their products. Also, it is experienced by PT. Mayer Indah Indonesia, which currently has 14 prospective suppliers, each of which has a different weight based on the assessment criteria of the company. The purpose of this study is to assist companies in making decisions to determine the best suppliers by using the Weight Product (WP) method, while the selection criteria are based on price, quality and the delivery accuracy. The results of the study can be implemented by the company to determine the right supplier in accordance with the criteria that have been required.

1. Introduction
Mayer Indah Indonesia corporation is a textile company located in Cibinong, Bogor, which its production needs of a yarn supplier as a provider of raw materials, in order to produce products optimally and to meet the market needs. So far, that corporation only focuses on price criteria as the main benchmark in selecting suppliers, this, of course, is able to be profitable of the company, because it is able to cut production costs. However, the suppliers sometimes are late in sending goods so the effect, it hinders the production process. For this matter, the quality of the goods should also be considered as a determining factor in selecting suppliers, so that the quality of the goods produced can also compete in the local market and even export fields[1].

The difficulty to choose the suppliers and the absence of standard criteria in determining suppliers [2] are the cause of the company who needs a decision-system making, that is able to help companies choosing suppliers with multiple criteria in accordance with company needs. One of the decision-making algorithms (Fuzzy Multi Attribute Decision Making/FMADM) that is suitable for several criteria in simple computational decision making, is the Weighted Product (WP) method. This method is already quite widely used in some similar cases [3][4][5], there are also applications in other fields such as laptop selection [6], residential selection [7] and even the selection of the best teacher [8].

This research is intended to help companies to determine the best supplier by using a decision-making method, that is Weighted Product (WP) with price, quality and delivery time criteria.
This method was chosen because of a simple algorithm by weighting each attribute and producing the best alternative of the selection.

2. Method
To obtain data in this study, the authors used two methods, they are: a. Interview Method. It conducts the interview session with company management to get the information about suppliers. b. Observation Method, It observes to get data related to the variables used to determine supplier selection criteria.

According to Yoon in [9] the Weighted Product (WP) method is a calculation method by multiplying the attribute rating where each attribute is first raised with the attribute weight. The steps in WP calculation are:
1. Determine the Criteria. The criteria in this case are variables that are used as a reference for determining selection decisions.
2. Determine the Match Rating. It suits the suitability rating of each alternative based on the value of each criterion.
3. Normalizing Weights. It is obtained from the weight of each criterion divided by the sum of all the weight criteria that meet the equation as follows: $$\sum_{j=1}^{n} W_j = 1 \ldots \ldots \ [1]$$
4. Determining the S Vector Value, it is obtained from the multiplication results of each criterion, where each criterion has been assigned the certain value, a positive rank for the benefit criteria and a negative rank for the cost criteria with the formula: $$S_i = \prod_{j=1}^{n} X_{ij} W_j , \ i = 1, 2, \ldots m \ldots \ldots \ [2]$$
   Where: S = Vector S, x = Criteria Value, w = Criteria Weight, i = alternative, j = criteria, n = number of criteria
5. Determining the V Value Vector, the value that is going to be used for ranking $$V_i = \frac{\prod_{j=1}^{n} X_{ij} W_j}{\prod_{j=1}^{n} (X_{ij}) W_j} , \ i = 1, 2, \ldots m \ldots \ldots \ [3]$$
6. Ranking V Value Vectors, ranking Vectors of V values, the highest result is the chosen alternative

3. Result And Discussion
1. Determination of Criteria In the selection of suppliers, there are several criteria that becomes a reference to be used as a standard calculation by using the WP method, these criteria are shown in table 1.

   | Criteria | Information | Weight |
|----------|-------------|--------|
| C1       | PRICE       | 5      |
| C2       | QUALITY     | 4      |
| C3       | DELIVERY    | 3      |

2. Determining the Match Ratings From the criteria in table 1, it is determined the importance level of the criteria for each weight. Ratings of each alternative are presented in table 2
Table 2. Alternative Ratings

| Criteria    | Range | Weight |
|-------------|-------|--------|
| Very High   | 81-100| 5      |
| High        | 61-80 | 4      |
| Is          | 41-60 | 3      |
| Low         | 21-40 | 2      |
| Very Low    | 0-20  | 1      |

3. Normalizing Weights From tables 1 and 2, it gets the weight value of each criterion, as shown in table 3

Table 3. Alternative Ratings

| Criteria | Weight Value |
|----------|--------------|
| C1       | 0,42         |
| C2       | 0,57         |
| C3       | 1,00         |

The alternative in this case is the supplier, where in this case there are 14 and from of the assessment’s company. While for the results are as follows:

Table 4. Alternative Ratings

| Supplier Code | Name Of Yarn Supplier            | Price Criteria | Quality Criteria | Delivery Criteria |
|---------------|-----------------------------------|----------------|-----------------|------------------|
| S1            | Asia Garment’s Accessories        | 75             | 70              | 50               |
| S2            | Benang Indah                      | 95             | 75              | 20               |
| S3            | GMS                               | 65             | 60              | 20               |
| S4            | Indachi Prima                     | 75             | 95              | 50               |
| S5            | Indonesia Toray Synthetics (ITS) | 80             | 70              | 30               |
| S6            | Joans Textile                     | 70             | 60              | 50               |
| S7            | Texfibre                          | 95             | 65              | 20               |
| S8            | Duniatext                         | 80             | 90              | 60               |
| S9            | Sudjaya                           | 65             | 80              | 55               |
| S10           | Korin Fancy Yarn Textile          | 70             | 95              | 60               |
| S11           | OST Fibre Industries              | 60             | 65              | 70               |
| S12           | Sinar Panca Mitra Indonesia       | 85             | 70              | 55               |
| S13           | Sulindafin                        | 70             | 70              | 50               |
| S14           | Surya Karya Sampoerna             | 70             | 90              | 60               |
By referring to the alternative assessment and rating criteria table, the weighting results for each alternative can be obtained as follows:

| Supplier Code | C1 | C2 | C3 |
|---------------|----|----|----|
| S1            | 4  | 4  | 3  |
| S2            | 5  | 4  | 1  |
| S3            | 4  | 3  | 1  |
| S4            | 4  | 5  | 3  |
| S5            | 4  | 4  | 2  |
| S6            | 4  | 3  | 3  |
| S7            | 5  | 4  | 1  |
| S8            | 4  | 5  | 3  |
| S9            | 4  | 4  | 3  |
| S10           | 4  | 5  | 3  |
| S11           | 4  | 4  | 4  |
| S12           | 5  | 4  | 3  |
| S13           | 4  | 4  | 3  |
| S14           | 4  | 5  | 3  |

4. Determining the Vector of S. The next step is to calculate the S vector of each alternative by the multiplication formula of each criterion, where each criterion is carried out by lifting the value of the weight criteria and weight values. The example calculation for alternative S1 (Asia Garment’s Accessories) the vector S value obtained from $(4^{0.42}) \times (4^{0.57}) \times (3^{1})$ shows the value of 11.80. The complete data can be seen in table 6.

| Alternative | Value |
|-------------|-------|
| S1          | 11.80 |
| S2          | 4.32  |
| S3          | 3.34  |
| S4          | 13.41 |
| S5          | 7.87  |
| S6          | 10.01 |
| S7          | 4.32  |
| S8          | 13.41 |
| S9          | 11.80 |
| S10         | 13.41 |
| S11         | 15.74 |
| S12         | 12.95 |
| S13         | 11.80 |
| S14         | 13.41 |
5. Determining the V Vectors Value
Determining the value of vector V is obtained by dividing the preferences of each alternative by the total number of vector S values.

| Alternative | Score    |
|-------------|----------|
| S1          | 0.0800   |
| S2          | 0.0293   |
| S3          | 0.0226   |
| S4          | 0.0908   |
| S5          | 0.0533   |
| S6          | 0.0678   |
| S7          | 0.0293   |
| S8          | 0.0908   |
| S9          | 0.0800   |
| S10         | 0.0908   |
| S11         | 0.1066   |
| S12         | 0.0878   |
| S13         | 0.0800   |
| S14         | 0.0908   |

4. Ranking of V Vectors
The final step of the WP method is to rank vector V values. From table 7, it has the highest value, that is S11, followed by S8 and S14 for the second position.

4. CONCLUSION
The test results show that the WP method was successfully applied to the case of selecting yarn suppliers at Mayer Indah Indonesia corporation. It uses three prospective supplier evaluation criteria, they are price, quality and delivery time. With the alternative of 14 representing suppliers who are in the highest ranking, the results can be supplier 11 (OST Fiber Industries) with a vector V value of 0.1066. Then there is supplier 8 (Duniatext) with a value of 0.0908 and supplier 14 (Surya Karya Sampoerna) with same value. With the implementation of the WP method, it is expected that companies will no longer choose suppliers subjectively or only assess their costs. In the future, the results of this study can be made to be the information system, that can be used by other textile companies. It is said so, to have the same assessment parameters to choose which supplier is the best.

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