www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

The Implementation of Simple Additive Weighting (SAW) Method to Selection of Plastic Raw Materials

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Abstract

Plastic is a polymer material widely used as a food and beverage packaging material due to the lightness and easy to use. The selection of quality plastic raw materials from industries engaged in plastic production are greatly affects the products produced. However, there are some mistakes occurred due to the selection process is carried out subjectively without any consideration, resulting in material losses for the company. The difficulty in determining superior plastic raw materials is one of them. The study attempts to select the best plastic raw materials using the Simple Additive Weighting (SAW) method. The research use five criteria for types of raw materials, namely: price, quality, production speed, plastic waste, location. Then, the plastic seeds brands used in this study are: Poly-max, El-pro, Titan, Polytan, and Trilene. The result of the study shows various result and present which seeds is the best to be used in the company.

Keywords
plastic; plastic raw material; plastic industry; material selection; simple additive weighting

I. Introduction

Plastics refer to a wide range of materials that can be extruded, molded, cast, spun, or coated as a coating at some point throughout the manufacturing process. Synthetic polymers are normally generated by polymerizing monomers sourced from oil or gas, and plastics are often made by adding various chemical additives to them (Thompson et al., 2009). Plastic plays an important role in everyday life, and it is commonly used as a food and beverage packaging material due to its lightness and practicality. The quality of a company's plastic raw materials has a significant impact on the end product. Organization must have a goal to be achieved by the organizational members (Niati et al., 2021). The success of leadership is partly determined by the ability of leaders to develop their organizational culture. (Arif, 2019). The company should be able to carry out all of its production operations properly if the raw materials are appropriately organized (Simon, 2019; Winursito, 2013). The amount of plastic produced in Indonesia varies year to year and is unpredictable. According to Hidayat et al. (2019), the highest level of plastic production in Indonesia was in 2012, when plastic production nearly reached 10.2 million tons. Plastic packaging, plastic melting, and plastic printing are all common forms of plastic processing. In Indonesia, most recyclers only sort and wash plastic waste. It is extremely rare for recyclers to melt the plastic into plastic seeds. Plastic waste is milled or crafted to produce secondary raw materials for plastic factories. Indonesia has also been processing plastic used in asphalt mixtures (Hidayat et al., 2019). However, Companies who run in producing plastic are frequently struggling to selecting the suitable raw materials for the manufacturing process. Mistakes are frequently occurred as a result of the selection process being carried out subjectively and without any consideration, resulting in material losses for the company.

Raw materials are the most basic requirements for a company to begin the manufacturing process. Since it was recognized that the properties of plastics and plastics of finite sources are the same, much effort has been put into the research and development of plastics to make plastics that can be used originally or first (Bahrom & Mohamed Ismail, 2013). There are many companies in many different research areas are trying to maintain the technology and resources to develop new plastic raw materials. One of the problems with plastic factories is that companies have difficulty in determining the superior plastic raw materials.

The problem is that plastic damage to the press on the roll is often due to poor quality or unsuitable raw materials for production. Therefore, the decision support program for the selection of plastic raw materials aims to make the right decisions in the selection of plastic raw materials. Hence, the study is conducted to design a system that can be used to decide the best plastic raw materials by implementing the Simple Additive Weighting (SAW) method.

II. Review of Literature

2.1. Simple Additive Weighting (SAW) Method

There are various fuzzy decision-making models. In general, these can be divided into two main groups: multiple attribute decision making (MADM), and multi-objective decision making (MODM) model. By applying the MADM approach, decision-makers choose from a finite set of choices. Each choice evaluates out of over the attribute. These attributes are usually competing with each other and have different meanings to decision-makers. Due to its simplicity and practicality, Simple Additive Weighting (SAW) is the most common method of traditional MADM. The SAW method is often referred to as the weighted summing method. The basic concept of a simple weighted method is to find the weighted sum of the performance evaluation of each choice of all attributes. It can be useful for decision-making, but when calculated this way, it gives only the maximum value selected as the best option. If the selected choice meets the specified criteria, the calculation will be performed according to this method. It is more efficient than other methods because it takes less time to calculate. The SAW method requires a process to normalize the decision matrix to a scale comparable to all current alternative ratings (Siahaan et al., 2017).

This method is based on a weighted average, and the rating score is measured by multiplying the normalized value of each criterion of interest by the importance of the criterion. Then rank the goals and select the goal with the highest score as the priority goal (Jaberidoost et al., 2015). The total score of the alternative is obtained by summing all the results of the multiplication between the score and the weight of each attribute. The rating of each attribute must be dimensionless. Passed the previous matrix normalization process (Siahaan et al., 2017).

The SAW calculation involves several steps, including (Siahaan et al., 2017):

a. Define the criterion as an evaluator of the benefits of the variable.
b. Determines the match rate for each choice of the specified criteria.
c. Create a decision matrix based on the criteria.
d. Performs normalization based on the benefits and costs of each attribute by using this following formula.

$$R_{ij} = \begin{cases} \dfrac{x_{ij}}{\max x_{ij}} \\ \dfrac{\min x_{ij}}{x_{ij}} \end{cases}$$

e. Determines the final score based on the defined weight of each R-value in the normalization matrix by using this following formula.

$$V_i = \sum_{j=1}^{n} w_j r_j$$

2.2 Data Collection

According to Bahrom & Mohamed Ismail (2013), there are several sorts of data must be prepared before doing the SAW computation, which are:

a. Criteria, defined as the data that containing code, name, attribute, weight. The weight of the criteria determines how important the criteria are. Attributes consist of benefit or cost, where the benefit means the greater the value, the better, while the cost, the smaller the value, the better.
b. Crisp, defined as the data that contains criteria, description, and weight codes. It is optional, i.e., like a barrier of the value of each criterion. Each crisp has its respective weights as in the above brackets. The weighting also affects the attributes of the criteria. Weighting should not be reversed.
c. Alternative is an option to be calculated and selected as the best alternative. Alternate data usually contains the candidate's target. It is a ranking choice.

III. Research Method

3.1 Data Collection Method

This research is a kind of quantitative method with a direct survey approach to the field. The data collection method for this study is based on observations and interviews. In this study, the observations were made directly at the study site, a company in the field of plastic manufacturing. The interview method is conducted through direct communication and question and answer with several employees in the production division and also the head of production. The data required for this study was obtained from company documentation by inquiring directly from plastic manufacturing in the form of a report on plastic raw materials. Researchers and production managers then conclude what caused the damage to the machined or printed plastic, and production managers complained about the inefficient selection of raw materials.

3.2 Determining the Criteria

There are five criteria in the trial, namely Price, Quality, Production Speed, Total of Plastic Waste, and Location as shown in Table 1.

Table 1. Criteria

Criteria	Remark	Weight
C1	Price	0.4
C2	Quality	0.1

C3	Production Speed	0.1
C4	Total of Plastic Waste	0.2
C5	Location	0.2

The five criteria aim to select the best raw in the selection. In the selection process, the study carefully considers the opportunity to be selected as a seed. Based on Table 1, hence the W = [0.4, 0.1, 0.1, 0.2, 0.2].

In determining the weight of this criterion, it is obtained based on the results of a direct survey at the location which is adjusted to the level of need of each criterion for the selection of plastic raw materials. the criteria that describe the profit or the greatest value for the company, then the type of criteria is *benefit*, while the criteria that describe the loss or value are small, the type of criteria is *cost*.

Each criterion has limits on the measured value. These values vary from criterion to criterion. The following is the determination of the value of each criterion.

a. Price

Table 2. Criteria of Price

C1	Weight	Type of Criteria
550000	1	Cost
575000	2	
625000	3	
675000	4	
700000	5	

b. Quality

Table 3. Criteria of Quality

C2	Weight	Type of Criteria
Bad	1	Benefit
Not good	2	
Quite good	3	
Good	4	
Very good	5	

c. Production Speed

Table 4. Criteria of Production Speed

C3	Weight	Type of Criteria
50 Mph	1	Benefit
57.5 Mph	2	
62.2 Mph	3	
67.5 Mph	4	
70 Mph	5	

d. Total of Plastic Waste

Table 5. Criteria of Total of Plastics Waste

C4	Weight	Type of Criteria
5.5 Kg	1	Cost
5.7 Kg	2	
6 Kg	3	
6.5 Kg	4	
7 Kg	5	

e. Location

Table 6. Criteria of Location

C5	Weight	Type of Criteria
3 Days	1	Cost
4 Days	2	
5 Days	3	
6 Days	4	
7 Days	5	

IV. Results and Discussion

The study collected the data direct from one company that operates in producing plastic. There are 5 names of alternative that used in this study, namely Poly-max, El-pro, Titan, Polytan, and Trilene. Each alternative has the criteria values as listed in Table 7 along with the category.

Table 7. Data Set

Alternative Code	Alternative Name	Criteria				
		C1	C2	C3	C4	C5
A1	POLY-MAX	3	2	3	2	3
A2	EL-PRO	4	2	4	2	4
A3	TITAN	2	4	3	2	3
A4	POLYTAM	3	4	2	3	2
A5	TRILENE	3	2	4	2	3

The next step is to create the decision matrix formed as follows:

$$X = \begin{vmatrix} 3 & 2 & 3 & 2 & 3 \\ 4 & 2 & 4 & 2 & 4 \\ 2 & 4 & 3 & 2 & 3 \\ 3 & 4 & 2 & 3 & 2 \\ 3 & 2 & 4 & 2 & 3 \end{vmatrix}$$

The next step is to normalize the matrix based on the type of criteria that has been adjusted to the type of benefit or cost criteria so that a normalized matrix can be obtained.

Alternative 1

$$R1.1 = \frac{min(3,4,2,3,3)}{3} = \frac{2}{3} = 0.667$$
$$R2.1 = \frac{min(2,2,4,4,2)}{2} = \frac{2}{2} = 1$$
$$R3.1 = \frac{min(3,4,3,2,4)}{3} = \frac{3}{3} = 1$$
$$R4.1 = \frac{min(2,2,2,3,2)}{2} = \frac{2}{2} = 1$$
$$R5.1 = \frac{min(3,4,3,2,3)}{3} = \frac{2}{3} = 0.667$$

Alternative 2

$$R1.2 = \frac{4}{max(3,4,2,3,3)} = \frac{4}{4} = 1$$
$$R2.2 = \frac{2}{max(2,2,4,4,2)} = \frac{2}{4} = 0.5$$
$$R3.2 = \frac{4}{max(3,4,3,2,4)} = \frac{4}{4} = 1$$
$$R4.2 = \frac{2}{max(2,2,2,3,2)} = \frac{2}{3} = 0.667$$
$$R5.2 = \frac{4}{max(3,4,3,2,3)} = \frac{4}{4} = 1$$

Alternative 3

$$R1.3 = \frac{2}{max(3,4,2,3,3)} = \frac{2}{4} = 0.5$$
$$R2.3 = \frac{4}{max(2,2,4,4,2)} = \frac{4}{4} = 1$$
$$R3.3 = \frac{3}{max(3,4,3,2,4)} = \frac{3}{4} = 0.75$$
$$R4.3 = \frac{2}{max(2,2,2,3,2)} = \frac{2}{3} = 0.667$$
$$R5.3 = \frac{3}{max(3,4,3,2,3)} = \frac{3}{4} = 1$$

Alternative 4

$$R1.4 = \frac{min(3,4,2,3,3)}{3} = \frac{2}{3} = 0.667$$
$$R2.4 = \frac{min(2,2,4,4,2)}{4} = \frac{2}{4} = 0.5$$
$$R3.4 = \frac{min(3,4,3,2,4)}{2} = \frac{2}{2} = 1$$
$$R4.4 = \frac{min(2,2,2,3,2)}{3} = \frac{2}{3} = 0.667$$
$$R5.4 = \frac{min(3,4,3,2,3)}{2} = \frac{2}{2} = 1$$

Alternative 5

$$R1.5 = \frac{min(3,4,2,3,3)}{3} = \frac{2}{3} = 0.667$$
$$R2.5 = \frac{min(2,2,4,4,2)}{2} = \frac{2}{2} = 1$$
$$R3.5 = \frac{min(3,4,3,2,4)}{4} = \frac{2}{4} = 0.5$$
$$R4.5 = \frac{min(2,2,2,3,2)}{2} = \frac{2}{2} = 1$$
$$R5.5 = \frac{min(3,4,3,2,3)}{3} = \frac{2}{3} = 0.667$$

Then, the results of the normalization matrix (R) of each alternative value are as follows.

Table 8. Results of Normalization Matrix

	C1	C2	C3	C4	C5
R	0.667	1	0.5	0.667	0.667
	1	0.5	1	0.5	1
	1	1	0.75	1	0.5
	1	0.667	0.667	0.667	1
	0.667	1	1	1	0.667

The next step is ranking which performed by the matrix multiplication process between the weight of the criteria (W) using the result of normalization (R) and the sum of the results of the multiplication of each choice. The best alternative is the one with the highest total value. Below is a ranking calculation that can be displayed using the following ranking process formulas.

W = [0.4, 0.1, 0.1, 0.2, 0.2]

V1 = (0.4*0.667) + (0.1*1) + (0.1*0.5) + (0.2*1) + (0.2*0.667)
= 0.8002

V2 = (0.4*1) + (0.1*0.5) + (0.1*1) + (0.2*0.667) + (0.2*1)
= 0.8834

V3 = (0.4*0.5) + (0.1*1) + (0.1*0.75) + (0.2*0.667) + (0.2*1)
= 0.7084

V4 = (0.4*0.667) + (0.1*0.5) + (0.1*1) + (0.2*0.667) + (0.2*1)
= 0.7502

V5 = (0.4*0.667) + (0.1*1) + (0.1*0.5) + (0.2*1) + (0.2*0.667)
= 0.7502

Based on the results of the SAW calculation in the test, it is concluded that the highest preference value for the selection of plastic seed raw materials is the alternative V2 with a value of 0.8834 which is the maximum value where there are superior plastic raw materials.

Table 9. Ranking

Alternative	Value	Ranking
A1	0.8002	Ranking 5
A2	0.8834	Ranking 4
A3	0.7084	Ranking 2
A4	0.7502	Ranking 3
A5	0.7502	Ranking 1

V. Conclusion

The SAW method is frequently used to determine the optimum decision for any purposes. This study used the method to select the finest plastic raw material which is the plastic seed brand, namely Poly-max, El-pro, Titan, Polytan, and Trilene. On the other hand, Price, Quality, Production Speed, Total of Plastic Waste, and Location are the criteria that used as a reference for decision making. The SAW calculation resulting that Alternative A2 as the optimum plastic raw material with the highest value as much as 0.8834. The brand of EL-PRO is selected as the best seed to processing the plastic. Determining the plastic raw material will help the company to decides the seed brand as expected. This method has the advantages to accurately evaluate the plastic raw evaluation.

References

Arif, S. (2019). Influence of Leadership, Organizational Culture, Work Motivation, and Job Satisfaction of Performance Principles of Senior High School in Medan City. *Budapest International Research and Critics Institute-Journal (BIRCI-Journal)*. P. 239-254

Aryza, S., Lubis, Z., & Khairunizam, W. (2019, February). Analisis hubungan antara daring dan revolusi industri didalam penerapan ilmu keteknikan. In Seminar Nasional Teknologi Komputer & Sains (SAINTEKS) (Vol. 1, No. 1).

Bahrom, A. Z., & Mohamed Ismail, R. (2013). *Shortage in supply of plastic raw materials for the plastic industry*.

Hidayat, Y. A., Kiranamahsa, S., & Zamal, M. A. (2019). A study of plastic waste management effectiveness in Indonesia industries. *AIMS Energy*, *7*(3), 350–370.

Jaberidoost, M., Olfat, L., Hosseini, A., Kebriaeezadeh, A., Abdollahi, M., Alaeddini, M., & Dinarvand, R. (2015). Pharmaceutical supply chain risk assessment in Iran using analytic hierarchy process (AHP) and simple additive weighting (SAW) methods. *Journal of Pharmaceutical Policy and Practice*, *8*(1), 1–10.

Niati, D. R., Siregar, Z. M. E., & Prayoga, Y. (2021). The Effect of Training on Work Performance and Career Development: The Role of Motivation as Intervening Variable. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, *4*(2), 2385–2393. https://doi.org/10.33258/birci.v4i2.1940

Siahaan, M. D. L., Elviwani, Surbakti, A. B., Lubis, A. H., & Siahaan, A. P. U. (2017). Implementation of Simple Additive Weighting Algorithm in Particular Instance. *International Journal of Scientific Research in Science and Technology*, *3*(6), 442–447.

Simon, B. (2019). What are the most significant aspects of supporting the circular economy in the plastic industry? *Resources, Conservation and Recycling*, *141*, 299–300.

Thompson, R. C., Swan, S. H., Moore, C. J., & Vom Saal, F. S. (2009). *Our plastic age*. The Royal Society Publishing.

Winursito, I. (2013). Perkembangan penelitian dan pemakaian plastik biodegradabel di Indonesia. *Journal of Industrial Research (Jurnal Riset Industri)*, *7*(3), 251–262.