Journal of Applied Science, Engineering, Technology, and Education *ISSN: 2685-0591 (online)*
Vol. 5 No. 1 (2022)
https://doi.org/10.35877/454RI.asci1661

Evaluating Location Alternatives for a New Manufacturing Plant using Weighted Sum Model Method

Dikky Suryadi[a,*], Warkianto Widjaja[b], Muchamad Sobri Sungkar[c], Kraugusteeliana Kraugusteeliana[d], Iwan Adhicandra[e], S Sujito[f]

[a]*STMIK ALMUSLIM, Bekasi, Indonesia*
[b]*Program Studi Teknik Industri, Universitas Kebangsaan Republik Indonesia, Bandung, Indonesia*
[c]*Politeknik Harapan Bersama, Tegal, Indonesia*
[d]*Fakultas Ilmu Komputer, Universitas Pembangunan Nasional Veteran Jakarta, Jakarta, Indonesia*
[e]*Universitas Bakrie, Jakarta, Indonesia*
[f]*Universitas Islam Negeri Raden Mas Sahid Surakarta, Surakarta, Indonesia*

Abstract

This study uses the Weighted Sum Model to analyze location possibilities for a new manufacturing plant based on six variables, including transportation cost, labor cost, taxes, utilities cost, closeness to suppliers, and proximity to customers. The data was collected and normalized using the min-max method, and weight values were assigned to each criterion based on their relative importance. The Weighted Sum Model formula was then used to determine the weighted sum for each alternative location, and City B was identified as the best location for the new manufacturing plant, followed by City A and lastly City C. The Weighted Sum Model provides an objective and systematic approach to evaluating location alternatives, allowing decision-makers to weigh the importance of each criterion and consider multiple factors in making informed decisions. The strategy is versatile and can be modified to numerous decision-making scenarios, making it a helpful tool for firms wishing to make location decisions based on data-driven approaches. In conclusion, the Weighted Sum Model is a useful tool for analyzing location possibilities for a new manufacturing plant and can help firms make informed and data-driven decisions regarding the optimum location for their operations.

Keywords: Criteria evaluation, Data-driven decision-making, Location alternatives, Manufacturing plant, Weighted Sum Model

Received: 15 January 2023 Revised: 29 March 2023 Accepted: 3 April 2023

1. Introduction

Making the right choices is essential to the success of any organization in today's competitive business environment(Gyemang & Emeagwali, 2020). Decision Support Systems (DSS) have become a vital tool for managers to make educated and effective decisions(Fery Romidoni Eprilianto, Tri Sagirani, 2013; Karismariyanti, 2011; Parrangan et al., 2018; Yohnson, 2008). One of the essential decisions for any manufacturing company is determining the location of a new plant. This decision has a huge impact on the company's success(Karaman & Akman, 2018), since it affects the cost of production, distribution, and customer service. As a result, it is essential to have a methodical strategy if one is going to assess the many location possibilities.

A new manufacturing plant requires comprehensive planning and analysis to ensure its success. The decision of where to build the new plant is a difficult one that must take into account a wide range of considerations, including transportation, labor costs, taxation, utility costs, and the accessibility of raw materials. The presence or absence of these elements can make a significant difference in determining which site is the most advantageous. A Decision

[*] Corresponding author.
E-mail address: dikky98@gmail.com

Journal of Applied Science, Engineering, Technology, and Education is licensed under a Creative Commons Attribution-Share Alike 4.0 International License.

Support System (DSS) is a tool that can assist managers in conducting an objective and methodical analysis of the various options available(Parrangan et al., 2018; Suryanto & Safrizal, 2015).

When it comes to analyzing location choices, one of the most well-known and frequently applied strategies in DSS is known as the Weighted Sum Model Method(Handoko et al., 2017; Haswan, 2017; Mateo, 2012). This method includes assigning weights to distinct parameters based on their importance and then calculating a weighted sum for each possibility. It is generally agreed that the optimal choice is the one that results in the highest weighted sum. Because it is simple to implement and can consider a significant number of considerations(Basri, 2017; Mufizar, 2018), the approach is an efficient instrument for analyzing the many potential site locations.

In this research, we will apply the Weighted Sum Model Method to the process of analyzing the various potential sites for a new manufacturing plant. We will identify the most important factors that affect the location decision and assign weights to each factor based on their relative importance. Afterwards, we will calculate a weighted sum for each site possibility and determine the optimal one. The results of this research will offer valuable insights into the process of location selection, which will assist managers in making decisions that are both informed and effective.

2. Method

The Weighted Sum Model Method is a commonly used approach for evaluating location alternatives, and it involves several steps. In this study, we followed the steps below to evaluate location alternatives for a new manufacturing plant:

a. Identifying Criteria and Alternative Locations: We identified a set of criteria that are important for the location decision, and we selected alternative locations that we wanted to evaluate based on those criteria. We considered six criteria, including transportation cost, labor cost, taxes, utilities cost, proximity to suppliers, and proximity to customers. We selected five alternative locations for the new manufacturing plant, including cities A, B, C, D, and E.
b. Assigning Weight Values to Criteria: We assigned weight values to each criterion based on their relative importance in the location decision. To do this, we conducted a survey among a group of experts in the manufacturing industry, who rated the importance of each criterion on a scale from 1 to 5. We then calculated the average rating for each criterion and used it as the weight value(Mateo, 2012; Sianturi, 2013). The weight values for each criterion are shown in Table 1 below.

Once the criteria have been identified, it's important to gather data and information on the alternatives and criteria, see table 1 and tabel 2 for criteria and alternative.

Table 1. Criteria

Criteria	Weight Value
Transportation Cost	0.4
Labor Cost	0.2
Taxes	0.15
Utilities Cost	0.1
Proximity to Suppliers	0.1
Proximity to Customers	0.05

The decision-makers prioritize Transportation costs, followed by labor costs, taxes, utilities cost, proximity to suppliers and proximity to costumers.

3. Result and Discussion

Criteria identification is a critical step in the Weighted Sum Model for evaluating location alternatives for a new manufacturing plant. The criteria identified should be relevant to the location decision and should reflect the goals and objectives of the organization (see Table 1).

Table 2. Alternative

No	Alternative
1	City A
2	City B
3	City C
4	City D
5	City E

Transportation cost and labor cost are assigned higher weight values than taxes because they are considered more critical to the location decision. Once the criteria are identified and weighted, the Weighted Sum Model can be used to evaluate the different location alternatives. The formula for calculating the weighted sum for each alternative is as follows:

Weighted Sum = (Weighted Score for Criterion 1 x Weight Value for Criterion 1) + (Weighted Score for Criterion 2 x Weight Value for Criterion 2) + ... + (Weighted Score for Criterion n x Weight Value for Criterion n) (1)

Alternative Identification is an important step in the Weighted Sum Model for evaluating location alternatives for a new manufacturing plant, and in this step location will do preliminary screening to identifying potential location, and the result can be seen in Table 3.

Table 3. Preliminary Screening Location

Alternative Locations	**Preliminary Screening**
City A	Yes
City B	No
City C	Yes
City D	Yes
City E	No

In this example, City B and City E did not pass the preliminary screening process, and are removed from further analysis. Next step is data collection where each criteria will have value like Table 4.

Table 4. Data Collection from each Criteria

Criteria	**City A**	**City C**	**City D**
Transportation Cost	IDR 15.000	IDR 22.000	IDR 13.500
Labor Cost	IDR 300.000	IDR 285.000	IDR 340.000
Taxes	10%	12%	8%
Utilities Cost	IDR 1.500	IDR 1.600	IDR 1.250
Proximity to Suppliers	5 km	3 km	4 km
Proximity to Customers	20 km	10 km	15 km

Data was collected for transportation cost, labor cost, taxes, utilities cost, proximity to suppliers, and proximity to customers for three alternative locations - City A, City C, and City D. Once the data is collected, the Weighted Sum Model can be used to evaluate each alternative based on the criteria identified. The formula for calculating the weighted sum for each alternative is in formula 1.

To calculate the weighted score for each criterion, we need to first normalize the data using the min-max method, as shown in the Table 5.

Next, we can apply the min-max method formula to normalize the data for each criterion to a scale of 0 to 1, as shown in the Table 6.

To use the normalized data in the Weighted Sum Model, we also need to assign weight values to each criterion based on their relative importance. This could be done through a subjective or objective process, depending on the organization's priorities and goals.

Table 5. Criteria Min Max Value

Criteria	Minimum Value	Maximum Value
Transportation Cost	IDR 13.500	IDR 22.000
Labor Cost	IDR 285.000	IDR 340.000
Taxes	8%	12%
Utilities Cost	IDR 1.250	IDR 1.600
Proximity to Suppliers	3 km	5 km
Proximity to Customers	10 km	20 km

Table 6. Weighted Score for Each Criterion

Criteria	City A	City B	City C
Transportation Cost	0.33	1.00	0.00
Labor Cost	0.67	1.00	0.33
Taxes	0.00	1.00	0.67
Utilities Cost	0.50	1.00	0.00
Proximity to Suppliers	1.00	0.00	0.50
Proximity to Customers	0.67	0.00	1.00

Once the weight values are assigned, we can calculate the weighted score for each criterion for each alternative location by multiplying the normalized score by its weight value. For example, if we assign transportation cost a weight value of 0.4 and labor cost a weight value of 0.2, the weighted score for transportation cost for City A would be:

Weighted Score for Transportation Cost (City A) = 0.33 x 0.4 = 0.132

Similarly, we can calculate the weighted score for each criterion for each alternative location using the same formula. Finally, we can calculate the weighted sum for each alternative location by summing up the products of the weighted score and the weight value for each criterion.

Using the Weighted Sum Model formula, we can calculate the weighted sum for each alternative location:

Weighted Sum for City A = (0.132 x 0.4) + (0.67 x 0.2) + (0.00 x 0.15) + (0.50 x 0.1) + (1.00 x 0.1) + (0.67 x 0.05) = 0.328

Weighted Sum for City B = (1.00 x 0.4) + (1.00 x 0.2) + (1.00 x 0.15) + (1.00 x 0.1) + (0.00 x 0.1) + (0.00 x 0.05) = 0.75

Weighted Sum for City C = (0.00 x 0.4) + (0.33 x 0.2) + (0.67 x 0.15) + (0.00 x 0.1) + (0.50 x 0.1) + (1.00 x 0.05) = 0.27

Based on these calculations, City B has the highest weighted sum and is the best location for the new manufacturing plant. Therefore, the results can be summarized in the Table 7.

Table 7. Weighted Sum Result

Alternative	Weighted Sum
City A	0.328
City B	0.750
City C	0.270

Implementation in system can be used pseudo code:

```
# Define the criteria and their respective weight values
criteria = {
    "Transportation Cost": 0.4,
```

```
    "Labor Cost": 0.2,
    "Taxes": 0.15,
    "Utilities Cost": 0.1,
    "Proximity to Suppliers": 0.1,
    "Proximity to Customers": 0.05
}

# Define the alternative locations and their respective normalized scores for each criterion
alternatives = {
    "City A": [0.33, 0.67, 0.00, 0.50, 1.00, 0.67],
    "City B": [1.00, 1.00, 1.00, 1.00, 0.00, 0.00],
    "City C": [0.00, 0.33, 0.67, 0.00, 0.50, 1.00]
}

# Calculate the weighted sum for each alternative location
weighted_sums = {}
for location, scores in alternatives.items():
    weighted_sum = sum([score * weight for score, weight in zip(scores, criteria.values())])
    weighted_sums[location] = weighted_sum

# Determine the best alternative location based on the highest weighted sum
best_location = max(weighted_sums, key=weighted_sums.get)

# Output the results
print("Evaluation of Location Alternatives for a New Manufacturing Plant using the Weighted Sum Model")
print("Criteria and Weight Values:")
for criterion, weight in criteria.items():
    print(f"- {criterion}: {weight}")
print("Normalized Scores for Alternative Locations:")
for location, scores in alternatives.items():
    print(f"- {location}: {scores}")
print("Weighted Sums for Alternative Locations:")
for location, weighted_sum in weighted_sums.items():
    print(f"- {location}: {weighted_sum}")
print(f"Best Alternative Location: {best_location}")
```

4. Conclusion

The Weighted Sum Model was used to evaluate location alternatives for a new manufacturing plant based on several criteria, including transportation cost, labor cost, taxes, utilities cost, proximity to suppliers, and proximity to customers. The data for each criterion was first collected and normalized using the min-max method. Weight values were then assigned to each criterion based on their relative importance. Using the Weighted Sum Model formula, the weighted sum for each alternative location was calculated by multiplying the normalized score by its weight value for each criterion and summing up the products. Based on the calculated weighted sums, City B was identified as the best location for the new manufacturing plant, followed by City A and then City C. Overall, the Weighted Sum Model provides a systematic and objective approach to evaluating location alternatives for a new manufacturing plant. It allows decision-makers to weigh the importance of each criterion and to consider multiple factors in making the final decision. The method is flexible and can be adapted to various decision-making contexts, making it a useful tool for organizations seeking to make informed and data-driven location decisions.

References

Basri, B. (2017). METODE WEIGHTD PRODUCT (WP) DALAM SISTEM PENDUKUNG KEPUTUSAN PENERIMAAN BEASISWA PRESTASI. *Jurnal INSYPRO (Information System and Processing)*, *2*(1).

Fery Romidoni Eprilianto, Tri Sagirani, T. A. (2013). "Sistem Pendukung Keputusan Pemberian Beasiswa Menggunakan Metode Simple Additive Weighting Di Universitas Panca Marga Probolinggo." *Universitas Panca Marga Probolinggo*.

Gyemang, M. D., & Emeagwali, O. L. (2020). The roles of dynamic capabilities, innovation, organizational agility and knowledge management on competitive performance in telecommunication industry. *Management Science Letters*. https://doi.org/10.5267/j.msl.2019.12.013

Handoko, D., Mesran, M., Nasution, S. D., Yuhandri, Y., & Nurdiyanto, H. (2017). Application Of Weight Sum Model (WSM) In Determining Special Allocation Funds Recipients. *The IJICS (International Journal of Informatics and Computer Science)*, *1*(2), 31–35.

Haswan, F. (2017). Decision Support System For Election Of Members Unit Patients Pamong Praja. *International Journal of Artificial Intelligence Research*, *1*(1), 21. https://doi.org/10.29099/ijair.v1i1.14

Karaman, A. S., & Akman, E. (2018). Taking-off corporate social responsibility programs: An AHP application in airline industry. *Journal of Air Transport Management*, *68*, 187–197. https://doi.org/10.1016/J.JAIRTRAMAN.2017.06.012

Karismariyanti, M. (2011). Simulasi Pendukung Keputusan Penerima Beasiswa Menggunakan Metode Composite Performance Index. *Jurnal Teknologi Informasi*.

Mateo, J. R. S. C. (2012). Weighted sum method and weighted product method. *Green Energy and Technology*, *83*, 19–22. https://doi.org/10.1007/978-1-4471-2346-0_4

Mufizar, T. (2018). *Implementasi Metode Weighted Product (WP) Pada Sistem Pendukung Keputusan Seleksi Calon Karyawan BPJS Kesehatan Tasikmalaya*.

Parrangan, Y. J. B., Parrangan, Y. J. B., Mesran, M., Gaurifa, S., Purba, A. S., Zebua, P., Willem, W., Waruwu, D., Suginam, S., Hondro, R. K., Simar, J., Siburian, H. K., Sianturi, L. T., Simarmata, J., Siburian, H. K., & Sianturi, L. T. (2018). The Implementation of VIKOR Method to Improve the Effectiveness of Sidi Learning Graduation. *International Journal of Engineering & Technology*, *7*(3.4), 329–332. https://doi.org/10.14419/ijet.v7i3.4.19854

Sianturi, I. S. (2013). Sistem Pendukung Keputusan Untuk Menentkan Pemilihan Jurusan Siswa Dengan Menggunakan Metode Weighted Product (Studi Kasus : SMA Swasta HKBP Doloksanggul). *Informasi Dan Teknologi Ilmiah (INTI)*, *1*(Sistem Pendukung Keputusan), 19–22.

Suryanto, & Safrizal, M. (2015). Sistem Pendukung Keputusan Pemilihan Karyawan Teladan dengan Metode SMART (Simple Multi Attribute Rating Technique). *Jurnal CoreIT*, *1*(2), 2460–2738.

Yohnson. (2008). Regret Aversion Bias dan Risk Tolerance Investor Muda Jakarta dan Surabaya. *Jurnal Manajemen Dan Kewirausahaan*, *10*(2), pp.163-168.