

Determination of Optimal Warehouse Location at PT. Sumber Alfaria Trijaya Tbk (Bali Branch)

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ABSTRACT : Location has a big impact on the overall risk and profit of the company. The choice of location will affect the distribution strategy of a company, one of which is distribution through a warehouse. PT SumberAlfariaTrijayaTbk is a retail company that uses distribution through a warehouse. In determining the location of a warehouse, the company will be faced with the consideration of the various required location selection criteria. This study uses Analytic Hierarchy Process (AHP) and Goal Programming (GP) methods. The results of this study indicate that the criteria with the highest to lowest priority in selecting a new warehouse location are rental price then distance, labor wages, transportation access, environmental conditions, and security level. Based on the calculation of AHP and Goal Programming, it shows 2 locations with the highest weight, namely Tabanan and Gianyar.

Keywords -Site selection, Analytic Hierarchy Process, Goal Programming

I. INTRODUCTION

Location has a big impact on the overall risk and profit of the company. The decision to choose the location needs to be considered because the location has a big influence on fixed and variable costs. Selection of the right location can reduce the company's transportation costs and shorten the delivery time both from manufacture to distributor and from distributor to customer, so that inventory control is easier and can increase service levels (Gallmann & Belvedere, 2016). Firms make relatively rare location decisions, usually because demand has exceeded existing plant capacity or because of changes in labor productivity, currency exchange rates, costs, or local behavior

There are several initial criteria that are taken into consideration in choosing a warehouse location. The criteria that influence the location of the distribution warehouse are: investment cost, expansion possibility, availability of material acquisition, human resources, and closeness to demand market. On the other hand, various criteria that influence the location of distribution warehouses are: population status, transportation conditions, market environments, location properties, and cost-related factors(Mao et al., 2016).

The choice of location will influence the distribution strategy of a company. One of the distribution strategies implemented by the company is distribution through a warehouse. In distribution through a warehouse, goods are not sent directly to customers but through one or more warehouses or supporting facilities. The use of a warehouse is very suitable for products with high demand / supply uncertainty. But on the other hand, using a warehouse will result in more costs such as capital costs, facility costs, operational costs, and transportation costs. Therefore, choosing the right warehouse location will have an impact on reducing costs that arise. Distribution through warehouse is very relevant to companies engaged in retail. One retail company that uses warehouse distribution is PT SumberAlfariaTrijayaTbk or known as Alfamart. This is marked by the expansion carried out by Alfamart by increasing the number of retailers from time to time



Figure 1. Number of Retailers Alfamart (2008 - March 2019)

Source: PT SumberAlfariaTrijayaTbk

The increase in the number of retailers indicates a high market opportunity for similar companies engaged in retail, especially minimarket-based companies. Similar companies are also required to be able to move responsively so that they can win the competition. One of the determinants of the success of a retail company is its distribution strategy. The implementation of a warehouse is a strategy used by Alfamart as a distribution channel for its goods, where each warehouse established by Alfamart includes one branch area according to the capacity that is adjusted to the conditions of each existing warehouse.

Alfamart Bali Branch which is located in Tulikup Village, Gianyar is also the Warehouse which is the distribution center for every Alfamart retailer in Bali. Delivery to each retailer is carried out in accordance with the stock of goods in each retailer with an integrated system between each retailer and warehouse in Gianyar. Thus, the demand for each item from each retailer fluctuates greatly every day. This is what causes the warehouse at one time to be short of goods and vice versa overload as a result of increased demand. This was what had happened before 2017 due to increased demand, so that Alfamart Bali moved its warehouse from the old warehouse in West Denpasar to TulikupGianyar. The increase in demand for Alfamart retailers from year to year must be anticipated at all times. The increasing demand will affect the warehouse capacity owned, so that someday there will be several alternatives, either by expanding the location or adding a warehouse in another location. Of course, in the alternative of adding a warehouse, a company must choose the most optimal location to avoid large losses. This is due to the fact that making a warehouse costs a very large investment, which returns in a long period of time.

In order to survive and develop its business, a decision-making method is needed that is used as a reference for the company (Alhawamdeh & Alsmairat, 2019). The problem of selecting the location of a distribution warehouse or warehouse includes problems related to multi-criteria decision making which is constantly developing, as well as the solving techniques. The choice of warehousing location is a multi-criteria problem that is widely studied today. So that it will be able to determine the optimal location based on the value of the subjectivity criteria and the criteria for objectivity (Varmazyar et al., 2016)

The decision-making process is not easy, because there are complex complexities associated with various alternative factors or different interests for each company (Sael et al., 2019). Sometimes in these alternatives there are dynamics of various kinds of interests that can be tailored to the needs desired by the company. It is this dynamic that can create multi-criteria problems in the decision-making process. For this reason, this study uses AHP (Analytic Hierarchy Process) analysis combined with Goal Programming by determining the minimum function of the AHP weighting criteria to determine the most optimal alternative (Pérez Vergara et al., 2020).

Based on empirical studies related to the use of Multi Criteria Decision Making, optimal results are obtained. Research using the AHP (Analytic Hierarchy Process) method is able to produce a more optimal alternative in determining the location according to research conducted by Capryani et al. (2016), Chenikwi (2016), Dey et al. (2016), Lobo et al. (2016), Triatmaja (2016), Wibowo & Tielung (2016), Susilowati (2019), Nurwarsito et al. (2016). Based on this study, all of them are able to provide alternative assessments of each sub-criteria to facilitate decision making for location selection. Other research conducted by Rully & Aldenia (2018), Trivedi & Singh (2017), Wichapa & Khokhajaikiat (2017), and Hocine et al. (2018) show the optimal location using the goal programming method in which the optimal warehouse location is obtained by determining the objective function of the location selection criteria.

Analytic Hierarchy Process (AHP) is a method of decision making to solve complex problems in unstructured conditions into a form of hierarchical arrangement. AHP was developed by Thomas L Saaty as a method that allows to assess, prioritize, rank, and evaluate decision choices and different factors of a hierarchical problem. AHP is also a technique that combines mathematical and psychological approaches to organize and analyze complex decisions (Cariño et al., 2020). The first step in AHP is to compile a hierarchy of problems. At the top level the hierarchy defines the main objectives of the whole decision making process. The second level of the hierarchy consists of criteria that contribute to the main goal, and at the lowest level consists of different alternatives (A. Kumar & Kumar, 2019). The second step is to arrange the elements at the second hierarchical level into a matrix and get an assessment of the relative importance of the criteria. The fundamental scale is between 1 and 9. A value of 1 means that it has the same level of interest as the criteria. Value 3 for medium importance level, 5 for essential or important importance level, 7 for very strong importance level and 9 for very important level of importance. The values 2, 4, 6 and 8 can also be used if compromise is required (Krejčí et al., 2017). The use of a scale and choosing the correct value for each criterion, in some cases is based on the importance of a subjective opinion. The same scale is also used when comparing the quality of the candidates with each other. So that decision making is not limited to the level of importance but rather on the superiority of the candidates (Emeç & Akkaya, 2018).

Goal Programming is the most powerful method of Multi Objective Decision Making that has been adopted to solve various problems in decision making (Dujardin & Chadès, 2018). Goal programming is a

method whose goal is to have the option to solve multi objective decision problems. This method allows the decision maker to be able to set the level of multi-choice aspiration for each goal which can be avoided so that no one underestimates the decision. Goal Programming is an important technique for decision making for a decision maker to solve multi-objective problems derived from the Multi Criteria Decision Making method. Goal programming can also be considered as an extension of linear programming to deal with usually conflicting objective problems and to find a series of satisfactory solutions (P. P. Kumar, 2019).

II. METHODS

This research is a case study which is a systematic and objective process of collecting, recording and analyzing data to assist in making business decisions. This research is a descriptive study using a quantitative approach which is intended to determine the optimal warehouse location with various criteria and alternative solutions. The data collection methods used were interviews and observations

Operational Definition of Variables

1. The rental price (RP) is an assessment of the amount of land rental price at the new warehouse location that will be used for business operations. The amount of the rental price is seen from the price per hectare per year.
2. Access to transportation (AT) is a condition of transportation facilities that supports distribution operations at that location. Transportation access is intended for principal companies to supply products to warehouse locations and to reach retailers from warehouse locations.
3. Radius distance to retailer (RD) is an assessment of the distance to the warehouse location of all existing retailers. The location of the warehouse in the center will produce a relatively low distance so as to increase the distribution range
4. Environmental Conditions (EC), is an assessment related to environmental conditions around the warehouse location. Good environmental conditions make distribution operations easier for a long period of time
5. Security Level (SL) is an assessment related to the level of security in the warehouse environment is established. The level of security can be measured by the intensity of crime in an area. (Coyle et al, 2017).
6. Labor Wages (LW) is an assessment related to the amount of labor costs. Labor costs can affect the operating costs of a company. The cost of labor varies from region to region. Labor costs can be measured through regional minimum wages

III. RESULTS

Results of Process Hierarchy Analysis

In the AHP method, the criteria are usually arranged in a hierarchical form. The criteria and in this study are those used by companies in choosing the location of distribution centers, which were obtained from the results of preliminary interviews. The problem of selecting a warehouse location at PT SumberAlfariaTrijaya, Tbk. Arranged in 3 hierarchical levels as shown in Figure 2. The first level is the goal, choosing the optimal warehouse location. The second level is the criteria in selecting the location of the distribution center, level 3 is the alternative location which should be chosen.

Selection of warehouse locations, the first priority of PT. SumberAlfariaTrijaya, Tbk, namely the criteria for the rental price with a weight of 0.391, then the second priority is the criteria for distance (radius to retailer) with an assessment weight of 0.260; The next priority is the criteria for labor wages, access to transportation, criteria for environmental conditions, and the level of security. The rental price is the company's first priority because it is related to the amount of initial investment required to build a distribution center. The cheaper the rental price at a location, the more efficient it is for business operations at that location, however, the location of the distribution center must have a radius of distance to all nearby outlets so that it can reduce distribution costs.

Table 1. Final AHP Alternative Location

	Criteria	Score	Alternative Score	Final Score
Denpasar	Rental Price	0.308	0.094	0.029
	Radius distance to retailer	0.251	0.295	0.074
	Labor Wages	0.199	0.135	0.027
	Access to transportation	0.105	0.106	0.011
	Environmental Conditions	0.084	0.093	0.007
	Security Level	0.054	0.106	0.006
	Total			0.154
Gianyar	Rental Price	0.308	0.316	0.097

	Radius distance to retailer	0.251	0.131	0.033
	Labor Wages	0.199	0.275	0.055
	Access to transportation	0.105	0.448	0.047
	Environmental Conditions	0.084	0.459	0.038
	Security Level	0.054	0.283	0.016
	Total			0.286
Tabanan	Rental Price	0.308	0.428	0.132
	Radius distance to retailer	0.251	0.092	0.023
	Labor Wages	0.199	0.485	0.096
	Access to transportation	0.105	0.283	0.030
	Environmental Conditions	0.084	0.305	0.026
	Security Level	0.054	0.448	0.024
	Total			0.331
Badung	Rental Price	0.308	0.163	0.050
	Radius distance to retailer	0.251	0.481	0.121
	Labor Wages	0.199	0.105	0.021
	Access to transportation	0.105	0.164	0.017
	Environmental Conditions	0.084	0.143	0.012
	Security Level	0.054	0.164	0.008
	Total			0.229

Source: AHP processing results,2020

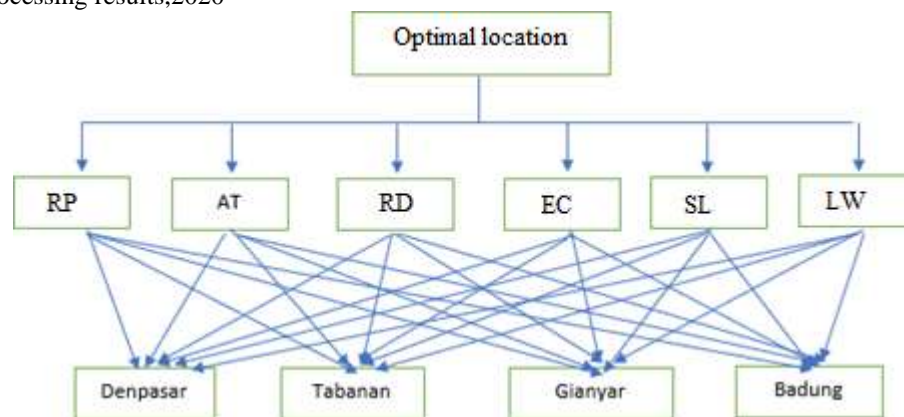


Figure 2. AHP on selecting a warehouse location

Goal Programming Analysis

Goal programming processing is carried out to obtain the best 2 locations from 4 alternative locations. The weight obtained in the previous processing is used as input in this processing. In this study, there are several objectives to be achieved. These objectives are then formulated in a mathematical equation into a constraint or constraint called the objective constraint function. In this objective constraint function, a deviation variable is included which indicates the possibility of a deviation. The value of this deviation should be as minimal as possible.

Goal 1 = The total cost of renting land that does not exceed the company's budget. The company's budget in choosing a location is not more than IDR 4,200,000 / 100m2 / year.

Goal 2 = Good transportation access with a road width of more than 25 meters

Goal 3 = Minimum average retailer distance

Goal 4 = Good environmental conditions

Goal 5 = A good level of security with a low regional crime rate

Goal 6 = Labor wages do not exceed the company budget

The objective function in this study is to minimize the deviational variable. The deviation variable is the deviation that occurs on the left side of an equation or constraint function on the right side. By minimizing these deviations, it is hoped that the optimization results obtained can approach the target to be achieved, namely by minimizing the deviation from the constraint function above.

$$MinZ = p1 + n2 + p3 + n4 + p5 + p6$$

The RHS value used comes from 2 times the value specified by the company. This aims to maximize the value the company wants to achieve. The following is the RHS value used in the goal programming formulation.

$$A = 4150 \times 2 = 8300$$

$$B = 24 \times 2 = 48$$

$$C = 360 \times 2 = 720$$

$$D = 0.305 + 0.038 = 0.343$$

$$E = 249 \times 2 = 498$$

$$F = 2700000 \times 2 = 5300000$$

Model Solutions

The results of processing with the help of LINGO 18.0 software show that the selected location is the location of Tabanan value 1 and Gianyar with value 1. The greater the value of an alternative, the more optimal the location is. In the reduced cost column, it looks at the ability of alternatives to minimize costs, whose value the smaller the better. The selected location is the location that has the highest value indicating that location

Table 2. Results of the LINGO Report

<i>Variable</i>	<i>Value</i>	<i>Reduced Cost</i>
Denpasar	0	63,62304
Gianyar	1,	0
Tabanan	1	0
Badung	0	30.74267

Source: processed data, 2020

IV. DISCUSSION

Analytic Hierarchy Process

In this study, there are 6 criteria that are considered by the company in determining the optimal warehouse location. These criteria include land rental prices, access to transportation, labor wages, radius, environmental conditions and level of security. From the results of data processing, it is obtained that the highest weight lies in the criteria for land rental prices, which is 0.308. This means that the criteria for land rental prices are more important than other criteria. The company considers that the rental price for land is important because the rental price will affect the initial investment of the company.

The criterion with second priority is the radius distance criterion. The low radius will affect the shipping cost. The lower the radius to the retailer, the lower the shipping costs. With a minimum distance, it allows companies to make fast deliveries and at low costs, as is the goal of supply chain management. Then the third criterion that is considered important is labor wages with a weight of 0.199. Labor wages are assessed through the Minimum Wage for each alternative location. The company considers that lower labor wages can reduce the operational costs of the warehouse. Then the fourth criterion is access to transportation with a weight of 0.105. The fifth criterion is environmental conditions with a weight of 0.084. Then the lowest criterion is the level of safety criteria with a weight of 0.054. The criteria for environmental conditions and the level of safety are given relatively small weight considering that the company considers that these criteria are easier to overcome when compared to other criteria.

Table 3. Result of Alternative AHP Location

	Denpasar	Gianyar	Tabanan	Badung
Rental Price	0,029	0,097	0,132	0,050
Radius distance to retailer	0,074	0,033	0,023	0,121
Labor Wages	0,027	0,055	0,096	0,021
Access to transportation	0,011	0,047	0,030	0,017
Environmental Conditions	0,007	0,038	0,026	0,012
Security Level	0,006	0,016	0,024	0,008
Total	0,154	0,286	0,331	0,229

Source: processed data, 2020

Based on table 3, Tabanan is superior to other alternative locations. The AHP weighting result is the result of the respondent's subjective assessment. To optimize the results based on data in the field for several criteria that are considered by the company, it is necessary to calculate goal programming.

Goal Programming

Goal programming processing includes objective values with input data in the field from each alternative seen in each criterion. Z value is optimal if the value is close to RHS. Negative deviations and positive deviations indicate how much less or more than the target goal (RHS). If the target value is achieved

properly, the deviation variable will approach the value 0. Based on the results of data processing using the LINGO solver, it was found that 2 locations that were considered optimal were Tabanan and Gianyar with a value of 1. The alternative location of Tabanan and Gianyar had the lowest deviation with a value of 0. This means that the two locations can be in accordance with RHS value which is the quantitative value of each criterion. While the alternative locations for Denpasar and Badung get a value of 0 so that these two alternative locations are not the optimal choice as a warehouse for PT SumberAlfariaTrijaya, Bali Branch. When viewed from the deviation of the goal constraints on goal 1 to goal 6, it can be said that the results obtained are optimal, because the deviation that occurs is less than 1.

Based on the results of the analysis, the company is advised to set up a warehouse in Tabanan so that it can change the initial distribution channel with 1 warehouse. The Tabanan warehouse alternative will handle distribution routers for the Jembrana, Tabanan, Badung, and Buleleng areas. Based on this, you will get a distance of 157.4 km. The addition of a warehouse in Tabanan was able to reduce the distance load from the original warehouse in Gianyar. The warehouse, which originally distributed throughout Bali, has now distributed to 5 districts, namely Denpasar, Gianyar, Klungkung, Bangli and Karangasem. Based on this, the distribution rate from the Gianyar warehouse becomes 95.5 km. Initially, the use of one warehouse had a radius of 355 km to each outlet in each district. The addition of a new warehouse resulted in a distribution distance of 252.9 km, so it can be concluded that the mileage decreased by 28.7%. This can happen because the old warehouse has a relatively far distance to the western part of Bali. With the addition of a warehouse in Tabanan, it is able to optimize the mileage so that the Gianyar warehouse will serve all Alfamarts in eastern Bali, while Tabanan will serve all Alfamarts in western Bali.

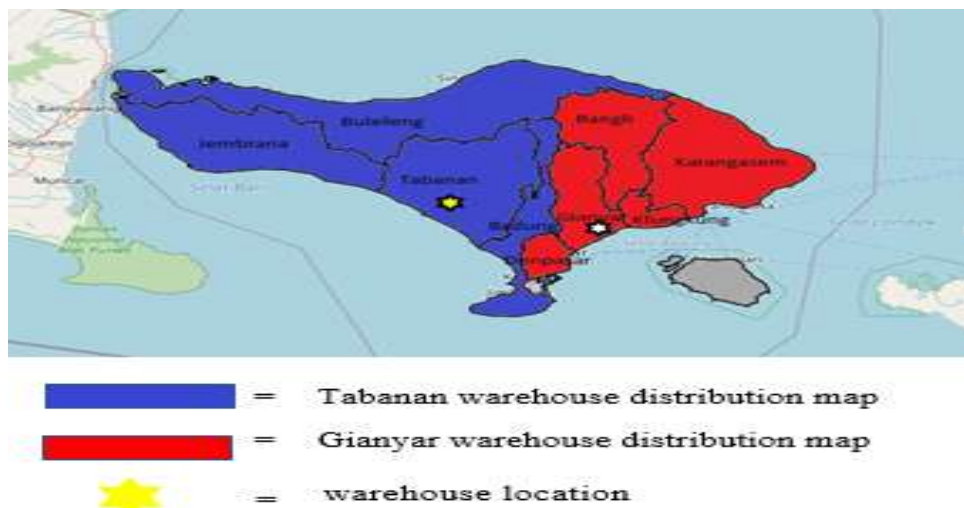


Figure 3. Selected alternatives

Source: processed data, 2020

Analytic Hierarchy Process is able to determine the priority level of each criterion according to the subjective assessment of company managers. The use of goal programming is able to determine the optimal location based on the objective values obtained from field data that support each criterion. So it can be concluded that in solving problems with many criteria or MCDM (Multi Criteria Decision Making) it can be resolved with the Process Hierarchy Analysis method and Goal Programming to determine optimal results (Ozdemir & Sahin, 2018).

V. CONCLUSION

The results of the weight calculation using the AHP method obtained the respective criteria weights of 0.308 for the criteria for rental prices; 0.105 for transportation access criteria; 0.251 for the radius to retailer distance criteria; 0.084 for the criteria for environmental conditions, 0.054 for the criteria for the level of safety; and 0.199 for labor wage criteria. The land rental price with a weight for each location is 0.094 for the Denpasar location, 0.316 for the Gianyar location; 0.482 for the location of Tabanan; and 0.163 for the Badung location. Based on the criteria for the distance to retailers with a weight for each location of 0.295 for the Denpasar location; 0.13 for the Gianyar alternative; 0.092 for the location of Tabanan; and 0.481 for the Badung location. Based on the criteria for labor wages with a weight for each location of 0.135 for the location of Denpasar; 0.275 for the Gianyar location; 0.485 for the location of Tabanan; and 0.105 for the Badung location. Based on the criteria for transportation access with a weight of 0.106 for each location for the Denpasar location; 0.448 for the Gianyar location; 0.283 for the location of Tabanan; and 0.164 for the Badung location. Based on the criteria for environmental conditions, each location weighs 0.093 for the Denpasar location; 0.459

for the Gianyar location; 0.305 for the location of Tabanan; and 0.143 for the Badung location. Based on the criteria for the level of security with a weight for each location of 0.106 for the Denpasar location; 0.283 for the Gianyar location; 0.448 for the location of Tabanan; and 0.164 for the Badung location. The optimal location is based on the calculation of goal programming by considering the six criteria (land rental price, transportation access, distance, environmental conditions, security level, and labor wages), namely alternative locations for Tabanan and Gianyar.

The company should consider adding a new warehouse in accordance with the predetermined location, namely the Tabanan location. With the addition of a warehouse located in Tabanan, it will give you the advantage of low rental prices and optimization of distribution distances to all Alfamart in Bali. The current warehouse location in Gianyar should be maintained because it is the optimal location for the location of Tabanan. **Further research** can use the transportation method and montecarlo simulation in testing new locations based on the results of the selection of the Analytical Hierarchy Process and Goal Programming methods so as to produce more accurate solutions.

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