Original Equipment Manufacturer (OEM) Site Selection of Traditional Medicine Companies in Indonesia using Analytic Hierarchy Process (AHP) Method

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Abstract. OEM Selection is a unique selection methods, it’s a combination of site selection and supplier selection. This study aims to determine the best location of the Original Equipment Manufacturer (OEM) in traditional medicine companies in Indonesia using Analytic Hierarchy Process (AHP) method. The results showed that the factors that have the highest weight in determining OEM locations are availability of raw material, transportation access and labor cost. The combination of these factors indicates that the best location for OEM development is Central Java province. This study is useful to provide insight to traditional medicine companies in Indonesia regarding the importance of determining the location of OEMs to build competitive strategies in the face of competition from competitors.

1. Introduction

The growth of traditional medicine industry market globally shows very rapid growth. Company in this industry must be able innovate to meet the dynamic needs of consumers requirements. Characteristic of traditional medicine industry which the product cycle is short with many types of product variants, able to adapt and to innovate continuously is one of the company's competitive advantages to survive in competition [1]. Traditional medicine industry in Indonesia has different regulation from Indonesian Food and Drug Agency (BPOM) on each product and will affect the way management in product development and marketing strategies. Fact that changes in consumer taste are not only in packaged food, but also in medicine industry drive company prepare flexible production lines and prepare new packaging machines to accommodate changes in consumer tastes [2]. Increasing standard minimum wage makes Cost of Goods Sold (COGS) increase and make product not competitive and not affordable for consumers who are sensitive to price, which are the biggest potential customers of traditional medicine in Indonesia. Many traditional medicine company looks for efforts to sustain in the business. The challenge is how to make low-cost products with realistic Minimum Order Quantity (MOQ) also have flexibility process due many SKU beside fulfill BPOM regulation. The choice is to produce products in their own facilities (in house) or find a place of production outside (outsourcer), with variety of considerations including in terms of labor costs, transaction costs, product security, product standardization. Outsourcing can be part of the production process or the entire production process. Some traditional medicine company, especially those located in the Jabodetabek industrial area ( around 25 km from Jakarta capital city ), are beginning to make survival efforts, one of effort move part or all of the production process to third parties who receive
OEM (Original Equipment Manufacturer). Therefore the choice of OEM is a strategic decision and can determine the continuity of the company.

2. Literature Review

2.1. Traditional Medicine
Traditional herbal medicine or *phytomedicines* is a treatment system that uses plants or parts of animals such as seeds, roots, leaves, flowers, oil and so on as the basic ingredients of the drug. Traditional medicine experts have been practicing this tradition for a long time using natural ingredients for treatment. WHO estimates that almost 80% of population of countries in Asia and Africa rely on traditional medicines for basic treatment. A large market caused by increase population elderly population, better consumer awareness, little or no side effects, innovation from producers and the existence of the rules of Current Good Manufacturing Practices (CGMP) for food supplements from the FDA (Food and Drug Association). Another factor is rising prices, a limited budget for modern medicine, all of which encourage consumers to consume cheaper traditional herbal medicines and safer side effects. Obstacles that are faced are the limited research and standardization of traditional herbal medicine systems, low law enforcement for regulation, regulation that make it difficult to patent a product and poor process in production [3].

2.2. Characteristic Traditional Medicine
A product is called traditional herbal medicine if have criteria as below [3]:

- a. Having an indication as a traditional medicine that is clearly visible from its composition and uses, can be used without supervision from medical practitioners for diagnosis or prescription or monitor care
- b. Products must be in accordance with the administration claimed and posology
- c. Products can be eat, external use or inhalation
- d. The usage period as a traditional medicine is at least 30 years including 15 years of use in the community.
- e. Based on data on the use of traditional medicines, in some cases traditional medicinal products have proven to be harmless to use and the pharmacological effects or effectiveness of treatment can be seen from existing usage experience.

2.3. Produce or Outsource
Decisions in making production or outsourcing are strategic and not easy decision. Once a decision is made, it is difficult to make changes. In the past few decades outsourcing has become a trend in manufacturing practitioners around the world by pushing down production costs and focusing on the core of their business. Some options in outsourcing are viewed from locations that are close to the main industry, or even different cities and different countries. Cheap labor costs remain a major factor in outsourcing and determining the location of outsourcing apart from improving quality and productivity and expanding markets [5]. When a product has gone through the development stage and entered into the commercial stage, it is time for operation department to determine where the product will be made, many factors must be considered including regarding available production facilities, price issues, quality, product safety and several other factors that become consideration. But in general the factors of production costs, especially labor costs are the main considerations [6]. When determining where the product will be made there are only two choices whether the product will be made in own facility or it will be done outside (Outsource) for part of the production operation or the entire production operation [7]. Further explained in determining the decision in outsourcing there are 4 key factors: choice location of outsourcing company, potential savings in labor costs, transaction costs, and the level of product complexity or standardization of the manufacturing process. After we determine the certainty to outsource, there are 3 considerations first is location of outsourcing company, second is competitive
labor costs that are the dominant factors and third is standardization of manufacturing processes that can also reduce transaction costs and also pre-conditions outsourcing [8].

2.4. Original Equipment Manufacturer
Outsourcing non-core activities in the top or bottom positions in the supply chain creates a dynamic business to provide value in the most efficient way so that many components can be made at lower costs on OEMs. Original Equipment Manufacturer (OEM) is defined as a company that produces goods in accordance with orders from other companies in accordance with the specifications given [9]. Currently OEMs have been widely practiced in the industrial world starting from the automotive industry where several parts components have been done at OEMs using brand owners. With the development of OEM capabilities, the tendency of OEMs to transform from just focusing on good and cheap products to ODM (Original Design Manufacturer) which has a focus on design innovation, in ODM products produced by design makers using the brand to order and finally becoming OBM (Original Brand Manufacturer) by starting to make markets and dare to display their own brands, in OBM products are made by brand owners [10]. The development of OEM supplier competencies depends on the progress of the OEM product buyers. The characteristics of the work environment and the different OEM supplier mechanisms lead to different OEM innovation capabilities. However, due to the rules set by buyers of OEM products that limit innovation and information data, OEM competencies in product design, product development and marketing not developed. In fact, the ability of OEMs to take advantage of external environmental factors will have the effect of competency which affects the competency of OEM service users [11].

2.5. OEM Selection
Before communication with prospective OEMs, all parties must sign a confidentiality agreement (Non-Disclosure Agreement - NDA) on information provided by both parties. When the OEM has been compared, the weighting of the criteria from each OEM is done. In selecting an OEM there are 2 steps that must be done. The first stage is location selection by considering topography, social culture conditions, industrial facilities, access to transportation, availability of resources, rules and regulations that must comply in OEM site location and integrity of government that controls and has the authority of the area. The second stage after we select OEM location is selection OEM company, OEM company selection can be done with supplier selection method approach by the purchasing department with consideration of price, quality and ability to deliver.

2.6. Site Selection
The purpose of the site selection is to find the optimum location that meets the selected selection factors. The process of site selection generally consists of two stages, namely screening and evaluating. In the first step is to identify several candidate locations from geographical locations and calculate the number of appropriate selection criteria. The second stage is to evaluate the assessment thoroughly and carefully to find the right location alternative [12]. Site selection is very strategic, and very fundamental and is the company's long-term decision [13], and has an impact on the company's success in the short and medium term. To prevent site selection mistakes, the selection of methods in site selection is very important. The choice of method in determining location is determined from the product to be made and also not an easy task due to the large number and limits of the criteria that must be considered. It will be even more difficult if the location intended is a global location in different countries and continents that will increase complexity. Careful analysis of site selection on the specific needs of the production process to be carried out at OEMs is a precondition that must also be taken to avoid mistakes [14]. Please note that site selection is the initial phase of a project, this causes the results of the analysis of site selection will determine the final outcome of a project. The use of several different methods or theories sometimes produces different final results. This does not immediately become a reference that the end result is wrong or correct or even may not be used. Many aspects must be considered in making the right method selection, consideration of the type and quality of the available criteria become base evaluation.
Each method has the advantage of each on the other hand also has limitations that differ from one method to another. In recent years AHP methods is proposed for site selection for example Mohajeri (2010) use for railway, Hong (2011) use for emergency logistic center, Akkas (2017) use for solar power plant, Singh (2016) use for facility site selection and Hashemi (2017) use for industrial land fill. We use AHP methods in this research because AHP is a flexible multi-criteria decision-making methodology that transforms a complex problem into a hierarchy with respect to one or more criteria.

3. Methodology

AHP is a scientific method that helps decision making based on variety of criteria or called by the Multi Criteria Decision Making (MCDM) [15], this method does not require quantitative information about each alternative. On the contrary, this is based on the valuation of the people or experts who make decisions [16]. This preference depends on the scores set in paired comparisons, where criteria are evaluated on an intensity-importance scale from one to nine. After the decision maker evaluates the criteria using the scale described above, a comparison matrix is made which contains paired comparisons of all different alternatives or criteria. In this matrix, all elements are positive and have the nature of reciprocity and consistency. Consistency is calculated using a consistency ratio, which reflects how consistent the valuation is relative to the sample randomly. If the consistency ratio exceeds 10%, the assessment is considered to be unreliable [17].

3.1. Determination of Hierarchy

Figure 1 shows a four-tier hierarchical model for the choice of location issues for traditional drug company OEMs in Indonesia.

![Figure 1. Model hierarchy for the selection of locations for OEMs for Traditional Medicines in Indonesia](image)

The first level presents the purpose of the problem, namely finding the province of traditional OEM drug locations among prospective candidates. As shown in the second level, the purpose of this model is divided into seven main criteria, namely those related to transportation (C1), telecommunications
(C2), environment (C3), raw materials (C4), labor (C5), energy sources (C6) and good government (C7). On the third level which is sub-criteria consists of 17 sub-criteria related. The sub criteria are availability of mode transportation (C11), transportation access (C12), fuel access (C13), telecommunication network (C21), environment regulation (C31), raw material availability (C41), packaging material availability (C42), price of raw material and packaging material (C43), minimum weight (C51), worker skill (C52), worker background education (C53), electrical supply (C61), water supply (C62), government integrity (C71), public relation (C72), public services (C73) and partnership (C74). Three provincial alternatives at the final level of the proposed hierarchy model.

3.2. Determination of alternative provinces

There are 134 traditional medicine companies in Indonesia in 12 provinces of total 34 provinces. East Java, Central Java and West Java located is province on Java Island (Fig 2.) have 88 traditional medicine companies from a total of 134 companies in Indonesia (around 66%). Those province is the most populated province in Indonesia neighbor of Jakarta capital city.

![Figure 2. Map of the provinces in Java](image)

3.3. Weighting Criteria

In hierarchical analysis, the greatest weight is given to criteria that have the greatest impact in determining alternative objectives [18]. In the study that carried out the criteria weighting was carried out by a survey conducted on 6 experts who worked in leading traditional medicine companies in Indonesia on Table 1. To determine the level of importance between the criteria given, this level of importance is assessed in pairs between existing attributes using a scale on the AHP method, namely 1-9 [19]. Table 2 shows the weight of criteria and factors based on preference through wise partner comparison.

| List of Expert | Position           | Experience | Company Name and Location          |
|----------------|--------------------|------------|------------------------------------|
| Expert 1       | Plant Manager      | 15 years   | ENS, Jakarta                       |
| Expert 2       | R&D Sr Manager     | 12 years   | ENS, Jakarta                       |
| Expert 3       | Plant Manager      | 20 years   | AM, Central Java                   |
| Expert 4       | GM Manufacturing   | 20 years   | CPG, Central Java                  |
| Expert 5       | Plant Manager      | 15 years   | DLT, Central Java                  |
| Expert 6       | Business Sr Manager| 15 years   | MRL, West java                     |
Table 2. Weighting factors based on the preference through pair-wise comparison

| Preferences                  | Value |
|------------------------------|-------|
| Extremely preferred          | 9     |
| Very strongly preferred      | 7     |
| Strongly preferred           | 5     |
| Moderately preferred         | 3     |
| Equally preferred            | 1     |
| Preferences between strong distance | 2, 4, 6, 8 |

3.4. Consistency Test

To ensure opinions of experts can be used as a reference, a consistency test is carried out by calculating inconsistencies from expert judgment in making pair comparisons. Good consistency is indicated by a value or index 0. The acceptable inconsistency value must be less than 10%. Pairwise comparisons, which are applied in the scope of the AHP technique, provide a comparison of the criteria used in decision analysis and determine the values for each criterion. In AHP, the matrix is created as a result of pairwise comparisons and criteria weights and also determines the consistency ratio (CR). Also, it is possible to determine the consistency ratio (CR) of decisions in pairwise comparisons. CR expresses a random probability of values obtained in a paired comparison matrix.

If n criteria are determined for comparison, the procedure is as follows to do AHP:

1. To make (n × n) pairwise comparison matrix for multiple factors, for Pijo to what extent we prefer factor i rather than factor j. Then assume \( P_{ij} = \frac{1}{P_{ij}} \).
2. Find for pairwise comparison matrices. Steps to be taken:
   a. Calculate the number of each column,
   b. Divide each entry in the matrix by number per column,
   c. Calculate the average in 1 row to get relative weights.

To estimated consistency of weight values, the consistency ratio (CR) is calculated as follows [20]:

\[
CI = \frac{1}{4} \left( \frac{\lambda_{max} - n}{n - 1} \right)
\]

where \( \lambda_{max} \) is the eigenvalue of the pairwise comparison matrix,

e. Finally, to ensure the consistency of pairwise comparison matrices, consistency assessments must be examined for the n values corresponding to CR

\[
CR = \frac{CI}{RI}
\]

where RI is a random consistency index. The RI values for different amounts of n are shown in Table 2.

If CR<0.10, the level of consistency is satisfactory. If CR ≥0.10, there are inconsistencies. In this case, AHP does not produce meaningful results.

Weight is calculated for all criteria by AHP and summarized in Table 3. Nineteen criteria are used in the calculation process, which are divided into two main groups. The CR value of all comparisons is lower than 0.10, means the weight is appropriate. Good consistency is indicated by a value or index 0. The acceptable inconsistency value must be less than 10%.
4. Result and discussion

The survey results from 6 experts concluded that there were 7 criteria in determining the location of OEMs for traditional medicines in Indonesia, namely transportation, telecommunications, environment, raw materials, labor, energy sources and government.

Next, a weighting criteria consistency test is carried out in which the results can be seen in table 3 where CIs are below 0.1, which means that the results of weighting criteria by experts can be used as a reference.

In the results of weighting the transportation gets the biggest weighting by 4 of the 6 experts who provide input, while the criteria for raw materials are considered as the biggest weight by 2 other experts.

| Main Criteria       | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 |
|---------------------|----------|----------|----------|----------|----------|----------|
| Transportation      | 0.271    | 0.255    | 0.207    | 0.259    | 0.206    | 0.127    |
| Telecommunication   | 0.087    | 0.061    | 0.066    | 0.053    | 0.058    | 0.058    |
| Environment         | 0.049    | 0.061    | 0.120    | 0.063    | 0.044    | 0.075    |
| Raw Material        | 0.212    | 0.206    | 0.185    | 0.158    | 0.227    | 0.265    |
| Labor               | 0.167    | 0.194    | 0.168    | 0.103    | 0.165    | 0.241    |
| Energy Source       | 0.155    | 0.164    | 0.133    | 0.159    | 0.128    | 0.187    |
| Government          | 0.058    | 0.059    | 0.121    | 0.206    | 0.172    | 0.051    |
| **Inconsistency (%)** | **7.89** | **6.67** | **5.47** | **9.41** | **8.80** | **8.30** |

The next step is to calculate the average of the weighting results to see the most influential criteria, from table 4 it can be seen that the criteria for transportation, raw materials and labor are the main criteria in determining the location of OEMs for traditional medicines in Indonesia.

| Criteria          | Weight |
|-------------------|--------|
| Transportation    | 0.230  |
| Telecommunication | 0.046  |
| Environment       | 0.050  |
| Raw Material      | 0.253  |
| Labor             | 0.180  |
| Energy Source     | 0.152  |
| Government        | 0.089  |

We use expert choice software to find final result and it show Central Java is become priority province to be consider for OEM traditional medicine site selection as shown fig 3.
5. Conclusions and Future Research
This study aims to provide stages in determining the location of OEMs for traditional medicines in Indonesia. The results showed that from the 7 criteria selected from the experts, 3 main criteria have biggest weight namely transportation, raw materials and labor. As well as 3 provinces that have the potential to become OEM locations, Central Java province is the best site location. For future research, the determination of the appropriate OEM traditional medicine company with two stages of determining the province with the AHP method and determining the company in the selected provinces by the ANP method.

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