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LOCATION DETERMINATION OF THE PT. X WAREHOUSE USING ANALYTICAL HIERARCHY PROCESS (AHP)

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Abstract: Currently COVID-19 pandemic is a biggest issue in the world. Of course it has an impact on the economics sector. X Company is engineering, procurement, and construction company, in which fire protection is their main business sectors. PT. X has several hydrant installation projects work at one time. In the process of working, many materials are used together by each project. And it could be a cost efficiency opportunity, especially in supplying the materials needed by projects. The company has 3 hydrant installation jobs in Cibinong, Halim, Cakung areas. In order to survive during this COVID-19 pandemic, the company feels the need to implement effective logistics management by creating a centralized warehouse in order to make warehouse management effective and efficient.

The Analytic Hierarchy Process (AHP) is a mathematical technique for multi-criteria decision making developed by Saaty. The research objectives in writing this paper were chosen based on 3 factors, namely infrastructure, government and market. Furthermore, this research is expected to help in determining the location of PT. Material X warehouse uses the Analytic Hierarchy Process method with alternatives in Cibinong, Halim and Cakung as well as infrastructure, government and market selection criteria.

Keywords: COVID-19, Effective Logistics Management, Analytic Hierarchy Process (AHP), Infrastructure, Government and Market

Introduction

Currently Indonesia is also facing COVID-19 pandemic, which is the biggest health issue. It started with a pneumonia cluster case with a new etiology in Wuhan City, China. On 11 March 2020, COVID-19 was designated as a pandemic. Indonesia first reported 2 positive cases on March 2, 2020 and a positive case continued to increase (Isbaniah, 2020). Key sectors have been affected, particularly travel and tourism, retail and other services sectors; business operations of the supply chains disrupted; employment and livelihood put at risks; while consumer confidence has declined. Instead, think of more targeted, self-sustaining and cost-effective ways to reduce the unnecessary expenses. The logistics infrastructure plays a vital role in increasing the capacity that leads to improved resilience against disaster (Dyah et al., 2014). One of the main success factors is the efficiency of logistics management (Moe & Pathranarakul, 2006). Logistics distribution in times of disaster is very important for emergency relief(Roh et al., 2015). Warehouses play an important role in natural

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disaster management, shelter procurement is certainly needed. (Caunhye et al., 2012). A good calculation to minimize the effort to save the suffering of the victim can be done by determining the best location. X Company are engineering, procurement, and construction company, in which fire protection is their main business sectors. PT. X has several hydrant installation projects work at one time. In the process of working, many materials are used together by each project. This could be a cost efficiency opportunity, especially in supplying the materials needed by projects. The company has 3 hydrant installation jobs in Cibinong, Halim, and Cakung areas.

Previous research related to the determination of warehouse locations has been conducted both in the context of commercial and humanitarian supply chains. Ko (2005) and Ashrafzadeh et al. (2012), for instance, proposed a decision-making model to decide the best location for commercial warehouses, using the analytic hierarchy process (AHP).

The Analytic Hierarchy Process (AHP) is a mathematical technique for multi-criteria decision making (Saaty, 1987). Where decisions involve many people such as planning, setting priorities, alternative actions from many choices and distribution of resources. The Analytic Hierarchy Process (AHP) is a robust and flexible decision-making process to determine the priorities of the qualitative and quantitative aspects that need to be considered. By minimizing complex decisions into a comparison, then analyzing the results not only that, AHP also provides reasons why the decision is the best.

In this study, AHP criteria were further clustered into three categories based on expert's opinion, i.e. infrastructure, government and market in accordance with the selection of warehouse location for a global supply chain (Singh et al., 2018). And this research is expected to assist in determining the location of the company material warehouse using the Analytic Hierarchy Process method with alternatives in Cibinong, Halim and Cakung as well as the selection criteria of infrastructure, government and market.

Criteria Identification For Warehouse Site Selection

Rajesh Kr Singha, Nikhil Chaudhary, and Nikhil Saxenab in their research said the main challenges for organizations to survive are reducing life cycles, reducing delivery lead times and customer satisfaction with service quality (Singh et al., 2018). Supply chain network optimization is needed to be a strategic decision in choosing an efficient

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warehouse location. (Mishra et al., 2011). Weber (1989) the concept introduced is to minimize the total distance between the warehouse and the customer's location. Martel and Vankatadri (1999), and Ozsen et al. (2008) learn about how to determine warehouse locations that can have an impact on the economy later (Sharma & Berry, 2006). The problem that occurs is setting the warehouse location to reduce transportation costs and warehouse location costs (Michel & Van Hentenryck, 2004). The algorithm used for the linear environment makes searching a taboo in determining warehouse locations (Colson & Dorigo, 2004). (PWSS) is used as a system to provide an opportunity for users to exploit warehouse databases, various types of information about warehouse locations in different countries (Ashrafzadeh, 2012). (Partovi, 2006) is taking into account external and internal criteria in the selection site a new analytical model was developed to support. To determine the most optimal location for a facility based on the deployment of a quality function which includes the analytical hierarchy process and the analytical network process concept (Tzeng & Chen, 1999). The proposed algorithm is based on a large-scale warehouse location search simulation and also the delivery of goods from or to the warehouse is expected to create a good transportation system wherever both land, sea and air transportation (Demirel et al., 2010). Electricity and water supply is an important role in the efficiency of the warehouse location it is part of the infrastructure (MacCarthy & Atthirawong, 2003). In addition, the scope of market expansion around the warehouse location in the future is also considered important because it provides an overview to the company. Supply chain efficiency and value can be further improved by selecting warehouse locations where government policies support the company (Min & Melachrinoudis, 1999). Government offers companies to invest in obtaining government policies covering land costs, existing tax structures at the site, legal guarantees and other incentives (Ashrafzadeh, 2012).

The research objectives in writing this paper were chosen based on 3 factors, namely infrastructure, government and market.

1. Infrastructure: In this category is meant such as roads, location of train stations, airports or ports, availability of electricity, water supply and means of communication.
2. Government: This category concerns government policies such as in terms of taxation and legal guarantees, incentives and land costs.

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3. Market: In this category is more concerned with the customer such as being close to the customer's location

Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a decision support model developed by Thomas L. Saaty. It can be defined as a multi-criteria problem which described into a hierarchy. Hierarchy known as a complex problem representative with many level structured started with the first level, which is the goal; second is the factor level, third is criteria, forth is sub-criteria, and last but not least is the alternative level. By using a hierarchy, a multi-criteria problem can be divided into several parts and then will be shaped into a hierarchical form, thus the result will become more systematic and structured.

To solve problems with AHP, there are three known principles, the first one is Decomposition which known as the principle of establishing a hierarchy, second one is Comparative Judgment or the principle of determining priorities, and the last one is the principle of Logical Consistency. In a question there is also a hierarchy, it is the hierarchy of problems that can be solved in considering the criteria or constituent in order to achieve the goals. When the objective and hierarchy of the goals is specified, important to consider is the specified objectives and the criteria involved are suitable for the current problem. AHP handles problems such as the following:

A company will buy new equipment with a certain type, there are four aspects to consider: cost, E; operation, O; reliability, R; adaptability or flexibility, F. The company's manufacturer administrators have offered options X, Y and Z. The company's engineers have analyzed and stated that X is cheap and easy to operate, but not very reliable and less suitable for adapting to other functions. Y is slightly more expensive, easy to operate, very reliable but hard to adapt. Then, Z is very expensive, difficult to operate, reliable than Y, but Z is claimed to have other functions. (Examples of hypotheses, understand them properly and think of other cases from one's experience). Each type will meet the company's requirements, but the company will choose the one that best suits the company's needs. Obviously this is a common problem and AHP has many applications but there are also limitations which will be discussed at the end of this section. Before providing some working examples of AHP, we first need

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to explain the underlying ideas. It is not necessary to understand matrix algebra to follow the flow of the argument but it does require mathematical skills to apply AHP.

AHP mathematics and computational techniques are briefly described in Appendix A but its essence is to construct a matrix representing the relative values of a set of attributes. For example, what is the relative importance to management of this company in terms of cost or ease of operation? Is cost important, more important, and just as important and so on to very less important as operability. Each of these ratings is numbered on a scale. One common scale (adapted from Saaty) is:

Table 1.

Intensity of importance	Definition	Explanation
1	Equal importance	Two factors contribute equally to the objective
3	Somewhat more important	Experience and judgement slightly favour one over the other.
5	Much more important	Experience and judgement strongly favour one over the other.
7	Very much more important	Experience and judgement very strongly favour one over the other. Its importance is demonstrated in practice.
9	Absolutely more important.	The evidence favouring one over the other is of the highest possible validity.
2,4,6,8	Intermediate values	When compromise is needed

A basic, but very reasonable assumption, is that if attribute A is truly more important than attribute B and is rated 9, then B should be really less important than A and rated 1/9. To consider all factors a comparison is made, usually no more than 7, and the matrix is complete. The matrix is a very special form, neat and supports further calculations. (Saaty was a very famous mathematician.)

The next step is to calculate a list of relative weights, importance, or values, of factors, such as cost and operability that are relevant to the problem in question (technically, these lists are called eigenvectors). If, perhaps, cost is much more important than operability, then, on a simple interpretation, inexpensive equipment is needed although, as it, is seen the problem is not easy for the final stage completion by performing a Consistency Ratio (CR) calculation to measure how consistent the assessment is relative to a large sample of pure random judgments. If the CR is much more than 0.1 the assessment cannot be trusted because it is too close for convenience, randomness and exercise are of no value or must be repeated. It is easy to make a minimum number in the score after which the remainder can be calculated in determining perfect consistency.

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Advances in Transportation and Logistics Research
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AHP is sometimes abused and the analysis stops with the calculation of the eigenvectors of the relatively important pairwise comparisons (sometimes without calculating the CR), in fact AHP is a Hierarchical Process. The first eigenvectors are of interest to requirements, such as cost and reliability, but contribution differences are also taken into account. Thus, the next matrix can be developed to show how X, Y and Z which meet the company's needs.

Discussion and Result

Initial stage is decomposition, it begins with the determine of a hierarchy consisting of Objectives, Criteria and Alternatives.

Objective

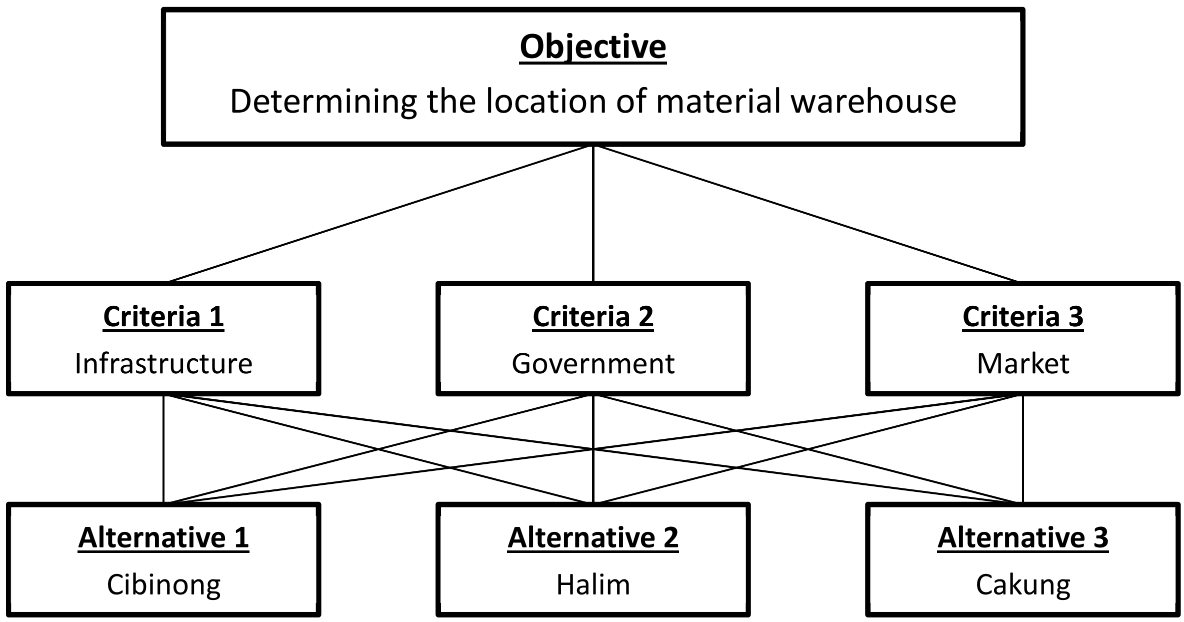
The objective has been determined according to the title of this research is determining the location of the material warehouse for used by PT. X project.

Criteria

Based on research from Rajesh Kr Singha, Nikhil Chaudhary, and Nikhil Saxenab, that is three criteria for selection of warehouse location are infrastructure, government and market. (Singh et al., 2018)

Alternatives

In 2020, The company have 3 project hydrant locations at same time that are Cibinong, Halim & Cakung.



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After the hierarchy, the ratings for each decision alternative & criteria are developed by expert. The expert who fill the rating is the director X Company. Because the person has the longest experience in managing the project especially for hydrant project. This table shows a comparison matrix of warehouse criteria and alternative are compared against each other. We know from the chapter 3 that The company has three criteria factors in infrastructure, government and market. The factors chosen should be independent, as required by Saaty's mathematics.

	Infrastructure	Government	Market
Infrastructure	1	1/4	1/5
Government	4	1	1/3
Market	5	3	1

Infrastructure	Cibinong	Halim	Cakung
Cibinong	1	5	8
Halim	1/5	1	5
Cakung	1/8	1/5	1

Government	Cibinong	Halim	Cakung
Cibinong	1	3	9
Halim	1/3	1	7
Cakung	1/9	1/7	1

Market	Cibinong	Halim	Cakung
Cibinong	1	5	3
Halim	1/5	1	7
Cakung	1/3	1/7	1

From table above expert determined has a different set of objectives. In their view, Government is more important than Infrastructure, and Market is more important than Infrastructure. Additionally for all alternatives, Cibinong is respectively much more important and absolutely more important than Halim and Cakung.

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The next step is developing a pair wise comparison matrix for each criterion:

	Infrastructure	Government	Market	AVG	[redacted]	Consistency Ratio (CR)
Infrastructure	1.000	0.250	0.200	0.096	[redacted]	3.022
Government	4.000	1.000	0.333	0.284	[redacted]	3.083
Market	5.000	3.000	1.000	0.619	[redacted]	3.155
	10.000	4.250	1.533	1	**CI =**	0.043
					RI =	0.580
					CR =	0.075

Infrastructure	Cibinong	Halim	Cakung	AVG	[redacted]	Consistency Ratio (CR)
Cibinong	1	5	8	0.711	[redacted]	3.312
Halim	1/5	1	5	0.223	[redacted]	3.116
Cakung	1/8	1/5	1	0.066	[redacted]	3.022
TOTAL	1.325	6.200	14.000	1	**CI =**	0.075
					RI =	0.580
					CR =	0.130

Government	Cibinong	Halim	Cakung	AVG	[redacted]	Consistency Ratio (CR)
Cibinong	1	3	9	0.649	[redacted]	3.150
Halim	1/3	1	7	0.295	[redacted]	3.082
Cakung	1/9	1/7	1	0.057	[redacted]	3.012
TOTAL	1.444	4.143	17.000	1	**CI =**	0.041
					RI =	0.580
					CR =	0.070

Market	Cibinong	Halim	Cakung	AVG	[redacted]	Consistency Ratio (CR)
Cibinong	1	5	3	0.580	[redacted]	3.954
Halim	1/5	1	7	0.310	[redacted]	2.651
Cakung	1/3	1/7	1	0.111	[redacted]	2.851
TOTAL	1.533	6.143	11.000	1	**CI =**	0.076
					RI =	0.580
					CR =	0,131

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And based on calculate above, final result is:

Final Result	Infrastructure	Government	Market	Total
Cibinong	**6.85%**	**18.44%**	**35.90%**	**61.19%**
Halim	2.15%	8.37%	19.19%	29.72%
Cakung	0.64%	1.61%	6.85%	9.09%
				100%

The reason Cibinong scores better than Halim and Cakung on these criteria are because its location is the biggest source of revenue. In addition, the location of Cibinong is close to the location of the intended client to reduce transportation costs. And also for the requirements of the Cibinong government can be easily fulfilled.

Based on (Özcan et al., 2011) there are five factors to be considered for deciding the problem of warehouse location, in other scenarios, criteria such as safety, cost, labor availability, and environmental factors.

Conclusion

Logistics is one of the important infrastructures. (Dyah et al., 2014) The research objectives in writing this paper were chosen based on 3 factors, namely infrastructure, government and market. The research has presented a decision-making model to determine the best location for a material warehouse in Cibinong was developed using AHP with three main categories.

The others model can be modified with combining AHP and other approaches to improve the decision-making. . This framework can be useful for organizations from various sectors to choose the optimal warehouse location for cost efficiency. Finally, the model is only applicable for hydrant project in 2020. If company have other project in the future, redetermination of several stages are needed in implementing the Analytical Hierarchy Process.

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