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DECISION SUPPORT SYSTEM LEGALIZATION OF DISTRIBUTION SUBSTATION WITH PRIORITY WEIGHTING BAYES METHOD

Andryas Yuli Anggoro[1], Sudarso K. Wiryono[2]
Institut Teknologi Bandung, Indonesia
E-mail: aans1987@gmail.com[1], sudarso_kw@sbm-itb.ac.id[2]

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ABSTRACT

PT PLN Batam is a national company operating in the field of electricity in the Batam region. As of December 2023, the number of customers is 367,709. Electricity consumption on Batam Island continues to increase with an average annual growth of 6.39% (2013-2023), and the average customer growth is 4.07% per year (2013-2023). This growth is accompanied by an increase in the assets of electricity distribution equipment, especially distribution substations. Distribution substations in PT PLN Batam consist of two types: concrete distribution substations and portal distribution substations. The total number of distribution substations as of December 2023 is 1,849. Distribution substations are vital distribution assets, requiring proper handling, especially regarding legal ownership of the land occupied by the substations. Land issues primarily occur in locations where distribution substations are situated in business centers or along main road medians. With the continuous increase in distribution substations, land legalization issues also escalate. To mitigate the risk of these land issues, PT PLN Batam implements the Decision Support System for the Legalization of Distribution Substations with Priority Weighting Bayes Method. This method, a qualitative approach, involves ranking distribution substations based on the highest to lowest risk. The goal of implementing the Bayes method is for the company to prioritize which distribution substations need to be legalized first and minimize land dispute issues in the future.

INTRODUCTION

Electrical energy consumption on the island of Batam continues to increase at an average growth of 6.39% per year (2013-2023), with growth in the number of customers on average of 4.07% per year (2013-2023). Significant growth is in line with the increase in asset distribution in one distribution substation (Berger, 2013).

Distribution substations in PT PLN Batam consist of concrete substations and substation portal packages. Where the number of distribution substations until December 2023 was as many as 1,849 pieces. The development of the number of distribution substations from 2013 to 2023 can be seen in Figure 1. Distribution substation is one vital asset distribution, so the a need for good handling of these assets, especially in terms of legal ownership of the land from the distribution substation (Lind et al., 2008).

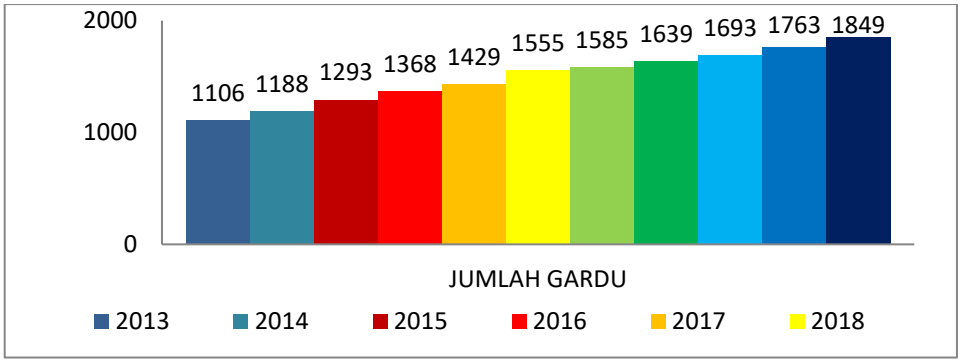

Figure 1
Graph Growth of Distribution Substation PT PLN Batam 20134 – 2023

Along with the continued increase in Distribution Substation, problems in legalizing their land are also growing. One of the problems of the land distribution substation that occurred in PT PLN Batam is the Wiramustika Distribution Substation. CV Wiramustika has been billed as the owner of the land rental fee to PT PLN Batam for the Distribution Substation owned by PT PLN Batam standing in his field site, the amount of the bill is valued at Rp 120 million/year (Daihani, 2001).

Land issues such as this should establish PT PLN Batam has the urgency to resolve any legality to its distribution substation. besides the Wiramustika Distribution Substation, Distribution Substation many more which have similar problems. There was also a some Distribution Substation that has been moved to another location because the distribution substation is located at the site of an industrial development project. All the problems of this area it should be resolved as soon as possible, so as not to cause problems in the future.

The objectives and benefits of the research are as follows:

1. The company can prioritize which Distribution Substations will be legalized first.
2. To prevent land dispute issues, such as those that occurred at the Wiramustika Distribution Substation, from happening at other Distribution Substations.
3. Cost efficiency in land legalization for the long term.

METHOD RESEARCH

Bayes method is a technique that can be used to perform the analysis in the decision making the best of several alternatives to produce an optimal acquisition. To produce the optimal decision consider a variety of criteria (Putro et al., 2020).

Baye's decision-making method is done by quantifying the likelihood of an event and expressed by a number between 0 and 1 or scale conversion. But often it is regarded as a personal or subjective probability Bayes where weights are based on the level of trust, confidence, experience, and background of the decision-makers (Sari et al., 2021).

Bayes equation used to calculate the value of each alternative is often simplified to:

$$Total\ Value\ _i = \sum_{j=1}^{m} Value_{ij}(Crit_j)$$

Where *Total Value*$_i$ is the final total value of the i^{th} alternative, *Value*$_{ij}$ is the value of the i^{th} alternative at the j^{th} criteria, *Crit*$_j$ is the importance level (weight) of the j^{th} criteria, i = 1,2,3,…n; n is the number of alternatives, j = 1,2,3,…m; m is the number of criteria.

The probability is obtained from an initial information can be subjective or objective. The value of these opportunities can be improved by the additional information obtained from a number of experiments. Initial information about the value of this opportunity is called prior distribution, while the value of the opportunities that are being improved with additional information is called posterior odds.

The stages of the research method used in conducting the study consist of four phases, namely:

1. Problem Identification, This is the initial stage of the research, aimed at formulating problems through observation (Hermawan, 2005).
2. Data Collection, Steps taken to gather the necessary data for testing using the chosen method. Additionally, data collection involves reading references such as scientific journals or e-books as language references to support the upcoming research (Kadarsah & Ramdani, 2002).
3. Calculation and Analysis of Data, Using the Bayesian method to calculate and analyze the data to obtain risk ranking results according to predefined criteria (Gelman et al., 1995).
4. Implementation, This phase involves applying the risk ranking results obtained through the Bayesian method to the distribution substation owned by PT PLN Batam, prioritizing them for legalization (Ramadhani et al., 2021).

RESULTS AND DISCUSSION

Bayes Criteria

Decision-making is an election action 'a' from a group of possible actions (A). Selection of action must be to know the result of the actions selected, which is usually a function of the status of the situation (state of nature). Status θ situation illustrates the real situation or circumstances in which the action will be applied (Supriono, 2017).

The value of the performance of each action **'a'** and θ status of the situation is described by using a pay-off matrix, which is shaped like the Table below:

A \ θ	θ_1	θ_2	.	.	.	θ_n
A_1	x	x	.	.	.	
A_2	x	x	.	.	.	
.	.	.	.	.	.	
.	.	.	.	.	.	
.	.	.	.	.	.	
a_m	.	.	.	.	.	

θ is the status of the situation which can be either the condition, the selection criteria, or the requirements of the election, **'a'** can be in the form of action, strategy, or choice, whereas 'x' is the value of the appearance of each action and the status of the situation. If the unit (unit) of every 'x' equals, then this matrix can be calculated directly for the election of the action. But if the unit of 'x' is not the same, this matrix must be transformed first into the form of a Comparative Performance Index (CPI), the way is to determine the minimum value for each

row (each status of the situation), and set the minimum value is equal to one hundred. Then another value in the same lanes as compared to the minimum value. A result of the selected action can be measured by assuming the existence of a function loss (loss function) with the symbol *l(a, θ)* which reflects the losses suffered when selecting the action 'a' on the status of the situation *θ*, and defined for each the combination of **'a'** and *θ* (Daihani, 2001).

Decision-making is done without a trial aided by the use of value opportunities before a procedure called Bayes criteria. In this procedure, the decision-maker will select the action that minimizes the alleged losses (expected loss) which is evaluated according to the prior probability value (Pertiwi, 2013). The calculation of the alleged loss *l(a)* for discrete θ is:

$$l(a) = E[l,(a,\theta)] = \sum l(a,k)P\theta(k) \text{ For all } k.$$

The calculation of the alleged loss for continuous θ is:

$$l(a) = E[l,(a,\theta)] = \int l(a,y)P\theta(y)dy$$

Bayes Procedure

Data obtained from the experimental results can be used in the decision-making process (Sebayang, 2014). The posterior probability distribution of θ is a conditional probability distribution of θ with a given $X = x$. The decision sought to first calculate the posterior probability distribution of θ for each $X = x$, after the selected action to minimize the losses alleged $l_n\,(a)$ which is similar to the risk statement, including the cost of the experiment. For θ discrete alleged loss calculation is:

$$l_n(a) = E[(l(a,\theta)] = \sum l(a,k)h_{\theta|X=x}(k)$$

Where $h_{\theta|X=x}$ is the distribution of discrete posterior probability. For continuous θ, expressn the posterior probability distribution $h_{\theta|X=x}$(y), the calculation of the alleged loss is:

$$l_n = E[l(a,\theta)] = \int l(a,y)h_{\theta|X=x}(y)dy$$

Application of Bayes Method on PT PLN Batam

Application of Bayes Method in PT PLN Batam is a process of selection of the Distribution Substation PT PLN Batam, amounting to a total of 1,849 pieces to be performed at a later legalization so that the risk to the issue of legalization of land mainly Distribution Substation can be reduced. The selection process with Bayesian method is classified based on several criteria, among which:

a. Land Position

Based on the analysis results, several data on the positions of PLN Batam's distribution substation land were obtained. The location of the substation land consists of 5 positions with scores arranged from the highest risk (score 5) to the lowest risk (score 1). Further details can be seen in Table 1.

Table 1
Land Position

Weight Score	Land Position
5	central business district
4	the outskirts of the business district
3	Industrial land
2	Government land
1	residence

b. Risk of Lawsuit

Based on the analysis of the risk of lawsuit criteria, 5 risks are ranked by score from the most likely probability to occur (score 5) to the least likely probability (score 1). Further details can be seen in Table 2.

Table 2
Risk of Lawsuit

Weight Score	Risk of Lawsuit
5	Very high probability
4	High probability
3	Moderate probability
2	Low probability
1	Very low probability

c. Risk of Displacement by the Government

Based on the analysis of the Risk of Displacement by the Government, it can be qualitatively categorized based on 5 risks with scores arranged from the location most at risk of displacement (score 5) to the least risk of displacement (score 1). Further details can be seen in Table 3.

Table 3
Risk of Displacement by the Government

Weight Score	Risk of Displacement by the Government
5	Main street median (national/province)
4	Sub-main street median (city/district)
3	Side of main street (national/province)
2	Side of sub-main street (city/district)
1	Residential roadside

Data Processing

Data of Distribution Substation number as many as 1,849 pieces will be weighted using Bayes method, will be selected next 14 Distribution Substation with the highest number of alternative values. this is because PT PLN Batam in 2023 to target only for the completion of land distribution substation as many as 14 pieces.

The calculation of the weighting matrix using the Bayesian method for the distribution substation of PT PLN Batam can be seen in Table 4 & table 5.

Table 4

Distribution Substation Alternatives	Criteria (weight)		
	0.3	0.4	0.3
	Land Position	Risk of Lawsuit	Risk of Displacement by the Government
GH Wiramustika	5	5	3
GD. Kampung Utama 2	5	4	4
GD Simpang jam batu batam	4	4	5
GD Simpang Pandan Wangi	4	4	5
GD Bumi Indah Ballyson	5	4	4
GD Nagoya City Centre	5	4	4
GD Komplek Wiramustika	4	4	3
GD Mak Ateh	4	4	3
GH Batam Center/Barelang	4	3	4
GH Mukakuning	4	3	4
GH Sagulung	4	3	3
GH Simpang Bandara	4	3	3
GD Polaris Sakti	4	3	3
GD Casanova	4	3	3

Table 4 shows the scoring results of PLN Batam's distribution substations according to three criteria of the Bayesian method (land position, risk of lawsuit, and risk of displacement by the government). The determination of these scores is done qualitatively based on field surveys and discussions with experts.

By using Bayes formula, the resulting value of alternatives are shown in the table below:

Table 5

Distribution Substation Alternatives	Alternative Value	Priority Index
GH Wiramustika	4.4	1
GD. Kampung Utama 2	4.3	2
GD Simpang jam batu batam	4.3	3
GD Simpang Pandan Wangi	4.3	4
GD Bumi Indah Ballyson	4.3	5
GD Nagoya City Centre	4.3	6

GD Komplek Wiramustika	3.7	7
GD Mak Ateh	3.7	8
GH Batam Center/Barelang	3.6	9
GH Mukakuning	3.6	10
GH Sagulung	3.3	11
GH Simpang Bandara	3.3	12
GD Polaris Sakti	3.3	13
GD Casanova	3.3	14

From the calculation of Bayes Formula, produced the highest to the lowest value of alternatives such as the table 5.

CONCLUSION

When Using Bayes Method, PT PLN Batam has conducted scientific decision-making process that can be responsible for the accountability. because by using this method, the management of PT PLN Batam can prioritize Distribution Substation to be legalized, so according to the Pareto principle, which is by focusing on the 20% main problem, it will be able to complete 80% of the risks that exist. In addition, the process is carried out with the aim that the problems as happened in Distribution Substation Wiramustika not occur in other distribution substation.

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