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# Determination of Locations for Planting Poles to Support Fiber Optic Cable Networks with the Moora Method

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**Abstract:** Telecommunication network is a series of telecommunications equipment and accessories used in conducting telecommunications activities. To build an optical network, the most important thing is to plant poles which will be used as network connectors . Pole planting is done based on several factors. In considering some of these factors, of course the company must make the right decision so that the projects carried out are in accordance with the company's targets. Making decisions manually will result in inaccurate and precise results. To reduce inaccuracies in making a decision, we need a system that can help and support companies in making a decision. The MOORA method works by giving weight to each specific criterion. From the weighting evaluation, the results with the highest ranking will be taken to determine decision making. From the results of the trials carried out, the best alternative system and analysis results were obtained from 20 data, namely jl.tuamang with community demand criteria of 47 people, population density of 372 people, moderate location access and distance between pillars of 45 meters with a result of 0.1499.

**Keywords** : Telecommunication Networks, Optical Networks, Moora .

## 1. Introduction

Telecommunications network is a series of telecommunications equipment and accessories used in conducting telecommunications activities. PT. Havo Anugerah Utama is a business entity engaged in the field of construction services that focuses its business on the construction of optical networks and other infrastructure related to telecommunication and data owned by other providers. To build an optical network, the most important thing is to plant poles which will later be used as a network connection from the server to the connecting poles up to the users. To carry out the planting of poles that support the optical network, of course there are several factors that

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must be considered so that the results achieved are in accordance with the company's achievements. These factors are community demand, population density, location access and distance between poles.

In considering some of these factors, of course the company must make the right decision so that the projects carried out are in accordance with the company's targets. The decision making will make the company hesitate to determine the location of the optical pole planting if some locations have results that are not much different from other locations. Making decisions manually will result in inaccurate and precise results. To reduce inaccuracy in making a decision, we need a system that can help and support companies in making decisions quickly and accurately.

The MOORA method works by giving weight to each specific criterion. From the weighting evaluation, the results with the highest ranking will be taken to determine decision making. The way the MOORA method works begins with determining the criterion values, the normalized matrix, calculating the maximum and minimum optimization values and determining the ranking of the calculation results.

Base Transceiver Station (BTS) is a device in a cellular telecommunication network in the form of a tower with a certain height complete with transmitting and receiving antennas and telecommunication equipment in a shelter. Determining the location of BTS in several areas has until now become a problem for a cellular operator or company engaged in the Internet sector, including at PT. Trinity Technology Archipelago. The problem is that when determining the location of the BTS tower it takes quite a long time. To be able to solve these problems, one way that can be proposed is to use a decision support system with the MOORA method. The MOORA method is a method that has calculations with minimum and very simple calculations. The results of this study are that the implementation of a decision support system using the MOORA method can provide a solution for companies in determining the location of BTS towers so that when determining the location it no longer takes a long time, the construction can run well and services to the community can be channeled optimally. . This research is reinforced by a journal from STMIK Triguna Dharma with the title "Decision Support System for Determining the Location of Tower Bts (Base Transceiver Station) at Pt. Trinity Technology Nusantara Using the Moora Method" by Tasya Utami Kusuma, Rico Imanta Ginting, and Dudi Rahmadiansyah.

The high cost of building a telecommunications tower is the reason for telecommunications providers to be truly selective and on target in determining the location of the tower construction. If not, the telecommunication provider company will suffer big losses. This paper presents a model of a computer-based system that uses the field of Artificial Intelligence in the form of a Decision Support System to support the management of telecommunications provider companies in choosing the right location for tower construction areas. The decision support system model combines the AHP method and the Moora method, where the AHP method is used to determine the weight of the criteria used based on their level of importance, while the Moora method is used to determine the best alternative to be selected. The results of the accuracy test showed that the combination of the AHP method and the Moora method had an accuracy rate of 71.43% at the seven locations tested. This research is reinforced by a journal from STMIK Triguna Dharma

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with the title "Priority Model for Regional Selection for the Development of Telecommunication Towers Based on the Combination of AHP Methods and Moora Methods" by Deski Helsa Pane and Kamil Erwansyah.

## 2. Literature

This previous research is one of the references in conducting research so that it can enrich the theory used in reviewing the research conducted. Some of these previous studies were used as references in enriching the study material in this study. Among the researchers, namely the decision support system for determining the location of the BTS tower (base transceiver station) at pt. the archipelago technology trinity uses the moora method. The results of this study are that the implementation of a decision support system using the MOORA method can provide a solution for companies in determining the location of BTS towers so that when determining the location it no longer takes a long time, the construction can run well and services to the community can be channeled optimally. (Kusuma et al., 2020).

Meanwhile (Helsa Pane et al., nd) with the title priority model for the selection of areas for the construction of telecommunication towers based on a combination of the AHP method and the MOORA method. From this study, the ranking results were obtained, the first priority decision recommendation for the area to be built by telecommunications towers was the Galang Region with the criterion data used being Availability of Electricity Very Supportive, The licensing process in the area is Very Easy, There is Road Access to the location of the telecommunications tower construction, Located in a very close cellular coverage area, the number of people served is dense, the availability of development land is available and the investment cost is Rp. 350 (million).

## 3. Methods

### 3.1. Types of Research

At this stage, we will discuss data input and the calculation process using the MOORA method. This process makes the selection according to predetermined criteria. Here are the steps taken in the calculation.

### 3.2. Alternative Data on Each Performance

Alternative data are then given a value based on the results of the assessment that has been carried out by research at PT. Havo Anugrah Utama. The alternative assessment on each criterion for determining the location of planting fiber optic cable network poles is as shown in the table below.

Table 1. Data on Locations for Planting Fiber Optic Cable Network Poles

| No | Address | Community Requests | Population density | Location Access | Distance Between Poles |
|---|---|---|---|---|---|

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| No | Address | Community Requests | Population density | Location Access | Distance Between Poles |
|---|---|---|---|---|---|
| 1 | Jl. Dahlia | 23 Customers | 256 Houses | Currently | 45 Meters |
| 2 | Jl. Master | 32 Customers | 415 Houses | Easy | 30 Meters |
| 3 | Jl. Fishing rod | 40 Customers | 402 House | Easy | 70 Meters |
| 4 | Jl. Spear | 37 Customers | 382 Houses | Easy | 45 Meters |
| 5 | Jl. ambai | 35 Customers | 389 Houses | Easy | 50 Meters |
| 6 | Jl. Tuamang | 47 Customers | 372 Houses | Currently | 45 Meters |
| 7 | Jl. Seser | 33 Customers | 361 Houses | Currently | 50 Meters |
| 8 | Jl. Splint | 31 Customers | 352 Houses | Easy | 55 Meters |
| 9 | Jl. Tempiling | 32 Customers | 377 Houses | Easy | 45 Meters |
| 10 | Jl. Tangku I | 25 Customers | 282 Houses | Currently | 50 Meters |
| 11 | Jl. Tangku II | 22 Customers | 276 Houses | Currently | 55 Meters |
| 12 | Jl. Torch | 27 Customers | 295 Houses | Currently | 50 Meters |
| 13 | Jl. Unity | 12 Customers | 101 Houses | Difficult | 35 Meters |
| 14 | Jl. Durung | 31 Customers | 353 Houses | Easy | 65 Meters |
| 15 | Jl. Often | 21 Customers | 212 Houses | Currently | 70 Meters |
| 16 | Jl. Piggy bank | 25 Customers | 182 Houses | Currently | 50 Meters |
| 17 | Jl. Willing | 21 Customers | 178 Houses | Currently | 45 Meters |
| 18 | Jl. challenge | 31 Customers | 323 Houses | Currently | 45 Meters |
| 19 | Jl. link | 26 Customers | 246 Houses | Currently | 50 Meters |
| 20 | Jl. Mulio | 33 Customers | 272 Houses | Currently | 55 Meters |

Then the alternative values for each criterion are transformed into fuzzy number values which have been described in the supporting data above based on the magnitude and level of importance of each value in each criterion. The transformation values are as shown in the table

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below.

Table 2 . Input Value Location for Planting Fiber Optic Cable Network Poles

| No | Alternative | Community Requests | Population density | Location Access | Distance Between Poles |
|---|---|---|---|---|---|
| 1 | A1 | 23 | 256 | 2 | 45 |
| 2 | A2 | 32 | 415 | 2 | 30 |
| 3 | A3 | 40 | 402 | 2 | 70 |
| 4 | A4 | 37 | 382 | 2 | 45 |
| 5 | A5 | 35 | 389 | 2 | 50 |
| 6 | A6 | 47 | 372 | 2 | 45 |
| 7 | A7 | 33 | 361 | 2 | 50 |
| 8 | A8 | 31 | 352 | 2 | 55 |
| 9 | A9 | 32 | 377 | 2 | 45 |
| 10 | A10 | 25 | 282 | 2 | 50 |
| 11 | A11 | 22 | 276 | 2 | 55 |
| 12 | A12 | 27 | 295 | 2 | 50 |
| 13 | A13 | 12 | 101 | 1 | 35 |
| 14 | A14 | 31 | 353 | 2 | 65 |
| 15 | A15 | 21 | 212 | 1 | 70 |
| 16 | A16 | 25 | 182 | 1 | 50 |
| 17 | A17 | 21 | 178 | 1 | 45 |
| 18 | A18 | 31 | 323 | 2 | 45 |
| 19 | A19 | 26 | 246 | 1 | 50 |

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| No | Alternative | Community Requests | Population density | Location Access | Distance Between Poles |
|---|---|---|---|---|---|
| 20 | A20 | 33 | 272 | 2 | 55 |

### 3.3. Application of the Method

This weight value is used to calculate the optimization value and get the ranking results. The weight values for each criterion are as shown in the table below.

Table 3. Criteria Weight Value

| No | Code | Criteria | type | Weight |
|---|---|---|---|---|
| 1 | K1 | Community Requests | Benefit s | 0.40 |
| 2 | K2 | Population density | Benefit s | 0.30 |
| 3 | K3 | Location Access | cost | 0.20 |
| 4 | K4 | Distance Between Poles | cost | 0.10 |

Based on the alternative input values for each criterion, these values are then formed into a matrix for calculations. The matrix of each value above is as follows:

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$$X = \begin{pmatrix} 23 & 256 & 2 & 45 \\ 32 & 415 & 2 & 30 \\ 40 & 402 & 2 & 70 \\ 37 & 382 & 2 & 45 \\ 35 & 389 & 2 & 50 \\ 47 & 372 & 2 & 45 \\ 33 & 361 & 2 & 50 \\ 31 & 352 & 2 & 55 \\ 32 & 377 & 2 & 45 \\ 25 & 282 & 2 & 50 \\ 22 & 276 & 2 & 55 \\ 27 & 295 & 2 & 50 \\ 12 & 101 & 1 & 35 \\ 31 & 353 & 2 & 65 \\ 21 & 212 & 1 & 70 \\ 25 & 182 & 1 & 50 \\ 21 & 178 & 1 & 45 \\ 31 & 323 & 2 & 45 \\ 26 & 246 & 1 & 50 \\ 33 & 272 & 2 & 55 \end{pmatrix}$$

From the matrix above, normalization is then carried out on the alternative values for each of the criteria above. The normalization process is as follows:

1. Normalization Column 1 Community Request Criteria
   Matrix Normalization (1,1) row 1 column1

$$x_{i,1} = \frac{z_{i,1}}{\sqrt{zi,1^2 + zi,1^2 + \cdots .... + zn,1^2}}$$

$$x_{1,1} = \frac{23}{\sqrt{23^2+32^2+40^2+37^2+35^2+47^2+33^2+31^2+32^2+25^2+22^2+27^2+12^2+31^2+21^2+25^2+21^2+31^2+26^2+33^2}} = \frac{23}{\sqrt{18206}} = 0{,}170$$

$$x_{2,1} = \frac{32}{\sqrt{23^2+32^2+40^2+37^2+35^2+47^2+33^2+31^2+32^2+25^2+22^2+27^2+12^2+31^2+21^2+25^2+21^2+31^2+26^2+33^2}} = \frac{32}{\sqrt{18206}} = 0{,}237$$

2. Normalization of Column 2 Population Density Criteria
   Matrix Normalization (1,2) row 1 column 2

$$x_{i,2} = \frac{z_{i,1}}{\sqrt{zi,2^2 + zi,2^2 + \cdots ........ + zn,2^2}}$$

$$x_{1,2} = \frac{256}{\sqrt{256^2+415^2+402^2+382^2+389^2+372^2+361^2+352^2+377^2+382^2+276^2+295^2+101^2+353^2+212^2+182^2+178^2+323^2+246^2+272^2}}$$
$$= \frac{256}{\sqrt{1957464}} = 0{,}183$$

$$x_{2,2} = \frac{415}{\sqrt{256^2+415^2+402^2+382^2+389^2+372^2+361^2+352^2+377^2+382^2+276^2+295^2+101^2+353^2+212^2+182^2+178^2+323^2+246^2+272^2}}$$
$$= \frac{415}{\sqrt{1957464}} = 0{,}297$$

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3. Normalization of Column 3 Location Access Criteria
   Matrix Normalization (1,3) row 1 column 3

$$x_{i,3}=\frac{z_{i,1}}{\sqrt{Zi,3^2+Zi,3^2+\cdots\ldots\ldots\ldots+Zn,3^2}}$$

$$x_{1,3}=\frac{2}{\sqrt{2^2+2^2+\ 2^2+2^2\ 2^2+2^2+2^2+2^2+2^2+\ 2^2+2^2\ 2+1^2+2^2+1^2+1^2+1^2+2+1^2+2^2}}=\frac{2}{\sqrt{65}}=0{,}248$$

$$x_{2,3}=\frac{2}{\sqrt{2^2+2^2+\ 2^2+2^2\ 2^2+2^2+2^2+2^2+2^2+\ 2^2+2^2\ 2+1^2+2^2+1^2+1^2+1^2+2+1^2+2^2}}=\frac{2}{\sqrt{65}}=0{,}248$$

4. Normalization of Column 4 Criteria for Distance Between Pillars
   Matrix Normalization (1,4) row 1 column 4

$$x_{i,4}=\frac{z_{i,1}}{\sqrt{Zi,4^2+\cdots\ldots\ldots\ldots\ldots+Zn,4^2}}$$

$$x_{1,4}=\frac{45}{\sqrt{45^2+30^2+70^2+45^2+50^2+45^2+50^2+\ 55^2+45^2+50^2+55^2+50^2+35^2+65^2+70^2+50^2+45^2+45^2+50^2+55^2}}=\frac{45}{\sqrt{52375}}=0{,}197$$

$$x_{2,4}=\frac{30}{\sqrt{45^2+30^2+70^2+45^2+50^2+45^2+50^2+\ 55^2+45^2+50^2+55^2+50^2+35^2+65^2+70^2+50^2+45^2+45^2+50^2+55^2}}=\frac{30}{\sqrt{52375}}=0{,}131$$

From the calculation of the normalization value above, the Normalized Value matrix (Xi) is obtained as follows:

$$X=\begin{pmatrix}
0.170 & 0.248 & 0.183 & 0.197\\
0.237 & 0.248 & 0.297 & 0.131\\
0.296 & 0.248 & 0.287 & 0.306\\
0.274 & 0.248 & 0.273 & 0.197\\
0.259 & 0.248 & 0.278 & 0.218\\
0.348 & 0.248 & 0.266 & 0.197\\
0.245 & 0.248 & 0.258 & 0.218\\
0.230 & 0.248 & 0.252 & 0.240\\
0.237 & 0.248 & 0.269 & 0.197\\
0.185 & 0.248 & 0.202 & 0.218\\
0.163 & 0.248 & 0.197 & 0.240\\
0.200 & 0.248 & 0.211 & 0.218\\
0.089 & 0.124 & 0.072 & 0.153\\
0.230 & 0.248 & 0.252 & 0.284\\
0.156 & 0.124 & 0.152 & 0.306\\
0.185 & 0.124 & 0.130 & 0.218\\
0.156 & 0.124 & 0.127 & 0.197\\
0.230 & 0.248 & 0.231 & 0.197\\
0.193 & 0.124 & 0.176 & 0.218\\
0.245 & 0.248 & 0.194 & 0.240
\end{pmatrix}$$

Next is to calculate the MOORA Multi-objective Optimization Value in this case referring to

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each criterion having its own weight (W). This optimization value is calculated for each given alternative. This value is the number of multiplication of the weight of the criteria with the maximum attribute value (max), namely the value of the attribute type benefit and the number of times the number of times the weight of the criteria, while the value of the attribute type cost is the product of the multiplication of the attribute value minus the multiplication result with max. The calculated values are as in the following calculations:

$A_1 = ( x_{1,1}*w_1 + x_{1,2}*w_2 ) - (x_{1,3}*w_3 + x_{1,4}*w_4))$

A1 = ((0.170*0.40) + (0.183*0.30)) - ((0.248*0.20) + (0.197*0.10)) = 0.0538
A2 = ((0.237*0.40) + (0.297*0.30)) - ((0.248*0.20) + (0.131*0.10)) = 0.1211
A3 = ((0.296*0.40) + (0.287*0.30)) - ((0.248*0.20) + (0.306*0.10)) = 0.1246
A4 = ((0.274*0.40) + (0.273*0.30)) - ((0.248*0.20) + (0.197*0.10)) = 0.1223
A5 = ((0.259*0.40) + (0.278*0.30)) - ((0.248*0.20) + (0.218*0.10)) = 0.1157
A6 = ((0.348*0.40) + (0.266*0.30)) - ((0.248*0.20) + (0.197*0.10)) = 0.1498
A7 = ((0.245*0.40) + (0.258*0.30)) - ((0.248*0.20) + (0.218*0.10)) = 0.1038
A8 = ((0.230*0.40) + (0.252*0.30)) - ((0.248*0.20) + (0.240*0.10)) = 0.0937
A9 = ((0.237*0.40) + (0.269*0.30)) - ((0.248*0.20) + (0.197*0.10)) = 0.1064
A10 = ((0.185*0.40) + (0.202*0.30)) - ((0.248*0.20) + (0.2185*0.10)) = 0.0631

## 4. Results And Discussion

From the results of the previous optimization value calculations, the results can be sorted from the largest to the smallest, where the optimization value of the largest alternative is the best alternative from the existing data and is the chosen alternative, while the alternative with the lowest optimization value is the worst of the existing data. . In order from the largest to the smallest, the ranking results are obtained as shown in the table below.

Table 4. Ranking Results

| No | Code | Alternative | Mark | rank |
|---|---|---|---|---|
| 1 | A6 | Jl. Tuamang | 0.1498 | 1 |
| 2 | A3 | Jl. Fishing rod | 0.1246 | 2 |
| 3 | A4 | Jl. Spear | 0.1223 | 3 |
| 4 | A2 | Jl. Master | 0.1211 | 4 |
| 5 | A5 | Jl. ambai | 0.1157 | 5 |
| 6 | A9 | Jl. Tempiling | 0.1064 | 6 |
| 7 | A7 | Jl. Seser | 0.1038 | 7 |
| 8 | A8 | Jl. Splint | 0.0937 | 8 |
| 9 | A18 | Jl. challenge | 0.0919 | 9 |

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| No | Code | Alternative | Mark | rank |
|---|---|---|---|---|
| 10 | A14 | Jl. Durung | 0.0896 | 10 |
| 11 | A19 | Jl. link | 0.0832 | 11 |
| 12 | A20 | Jl. Mulio | 0.0825 | 12 |
| 13 | A12 | Jl. Torch | 0.0718 | 13 |
| 14 | A16 | Jl. Piggy bank | 0.0665 | 14 |
| 15 | A10 | Jl. Tangku I | 0.0631 | 15 |
| 16 | A17 | Jl. Willing | 0.0560 | 16 |
| 17 | A18 | Jl. Dahlia | 0.0538 | 17 |
| 18 | A15 | Jl. Often | 0.0523 | 18 |
| 19 | A11 | Jl. Tangku II | 0.0508 | 19 |
| 20 | A13 | Jl. Unity | 0.0171 | 20 |

Based on the calculations that have been carried out using the MOORA method, the best alternative is obtained to determine the location for planting fiber optic cable network poles, namely A6 which is Jl. Tuamang with a value of 0.1498.

## 5. Conclusion

Based on the results and discussion of the decision support system to determine the decision results for determining the location of planting poles to support fiber optic cable networks, the following conclusions are obtained:

1. The MOORA method can be built using the PHP programming language for a system for determining the location of pole planting to support fiber optic cable networks.
2. From the weight value of the criteria for determining the location of planting poles, it can be applied using the MOORA method in determining the decision results for determining the location of planting poles to support fiber optic cable networks.
3. Based on the criteria for determining the location of pole planting, the best alternative system and analysis results were obtained from the 20 alternative data above, it can be seen that the one that obtained the best score or ranking was tuamang with community demand criteria of 47 people, population density of 372 people, moderate location access and the distance between the poles is 45 meters with a result of 0.1499.

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