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Minimizing Freight Transportation Costs With The Application Of Stepping Stone And Modified Distribution (MODI) Methods At PT. Tirta Success Perkasa

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Abstract
Minimizing Transportation Costs For Delivery Of Goods By Implementing The Stepping Stone And Modified Distribution (MODI) Method At PT. Tirta Sukses Perkasa (supervised by Rakhman Laba and Sumardi)
This study aims to analyze the average minimum transportation costs by using the Stepping Stone and MODI at PT. Tirta Sukses Perkasa.

Distribution can be defined as the process of distributing goods or services from producers to consumers. To distribute goods to a company, a means of transportation and distribution costs are needed to send the goods using transportation means. In a transportation problem, for example at PT. Tirta Sukses Perkasa can be formed into a transportation model. The transportation model can be completed in 2 stages, namely the initial solution with the Stepping Stone and the final solution using the Modified Distribution (MODI) method. This study aims to obtain transportation costs for PT. Tirta Sukses Perkasa. The results showed that the minimum transportation costs at PT. Tirta Sukses Perkasa from January to December 2019 using the Stepping Stone as the initial solution and the Modified Distribution Method (MODI) obtained a value of Rp. 91,331,902.

Keywords: Transportation, Stepping Stone, and Modified distribution method

PRELIMINARY

The development of the economic and business world today is getting faster and wider, thus causing all companies to be able to adapt and follow the current trading system and avoid the adverse effects of the existing economic and business system. Every economic and business actor must expect maximum profit so that their company can continue to operate and maintain their existence in the business and economic world. Because by maintaining and increasing sales, the main goals of the company will be achieved as expected.

There are several things that affect the increase in sales of a company, one of which is in the distribution sector. As we know that nowadays more and more companies are engaged in the distribution sector, which is triggered because the potential of these fields is very large. Distribution can be interpreted as the process of distributing goods or services from producers to consumers, and to distribute goods to a company, a

means of transportation is needed, either private transportation or public transportation/rental as well as distribution costs to send the goods. Then with the several transportation options currently available, companies must be smart in choosing, as well as utilizing and using them for the benefit of the company in achieving the main goals of what they expect.

Companies that have used the transportation model as a strategic tool for them will gain an advantage in terms of competition with other similar companies that do not use the transportation model as a strategic tool. Because by making the transportation model a company strategy tool, it will help the company in terms of saving operational costs, especially in the distribution of a company's goods. The distribution of goods that are handled properly and correctly will make the company get greater profits and minimize the occurrence of excessive costs in the distribution sector.

Transportation problems often occur when companies try to determine a solution or way of shipping their goods to several places to minimize costs. The delivery of the goods must be arranged as well as possible because in the process there will be differences in costs from one place to another when the distribution of goods is carried out. Then in this era, many companies have used the transportation model as a strategic tool, such as mineral water companies, which now have very rapid growth and development in today's business and economic world.

PT. Tirta Sukses Perkasa is one of the companies that produce mineral drinking water which has a fairly large development from year to year. The production of bottled mineral drinking water produced by PT. Tirta Sukses Perkasa was named Air Mineral Club. Of which there are several sizes, namely AMDK Club 19 lt, 1500 ml, 600 ml, 330 ml and 240 ml. PT. Tirta Sukses Perkasa in carrying out its activities of distributing goods to several areas, suppliers or consumers, using the company's private vehicle, where PT. Tirta Sukses Perkasa has several container cars as means of transportation from several factories to distribution destinations. The use of private vehicles, in the distribution carried out by the company, aims that the distribution process can go directly to some of their suppliers spread across several areas of South Sulawesi, Gowa, Makassar, Maros, Pangkep, Barru, Pare-pare, and Palopo etc. Of course, this requires a lot of money in its implementation. In the distribution of goods, companies sometimes experience an increase in the distribution costs of their goods because they use the direct distribution method. This distribution method starts from the factory to the destination with different distances, with this, the distribution cost budget is also different. Therefore, an effort is needed to reduce distribution costs by always paying attention to several things, one of which is unexpected costs. Then a careful planning and calculation technique is also needed so that the transportation costs incurred can be kept to a minimum.

One effort that can be done by the company is to use the transportation solution model as a method that helps solve the problem of product distribution. The transportation problem is part of the problem of linear programming. In its application, the first linear programming technique is to formulate transportation problems and solve them. There are several initial feasible settlement methods of the transportation model, namely North West Corner (NWC), Least cost and Vogel's Approximation Method (VAM).

Vogel's Approximation Method (VAM) is one of the initial solutions that are often used in distribution transportation methods that can overcome problems regarding distribution optimization, but the solution cannot be said to be optimal, this is because there are several previous studies that have proven that Vogel's Approximation Method (VAM) cannot be said to be optimal in solving distribution problems. Some

of these studies used several initial solutions, one of which was the VAM method, the results of which still needed to be optimized, so based on this, the cost optimization was carried out using the Stepping Stone and Modified Distribution (MODI) method as a solution to the optimization, so that costs tend to be more optimal. Stephing Stone is a transportation problem solving method that is used to manage the distribution of a product/goods from a source that provides the same product to a place or destination that needs it optimally. Modified Distribution (MODI). Modified Distribution (MODI) is a method of solving transportation cases, where the advantage is the determination of the empty point that can save costs, and can be carried out with more definite and precise procedures. Because of the importance of an appropriate distribution process in a company, it will be interesting for researchers to evaluate the distribution channels at PT. Tirta Sukses Perkasa to find a more optimal company distribution cost solution.

Research on the use of transportation methods at PT. Tirta Sukses Perkasa is not the first time this has been done, because in 2016, Ahmad has conducted research using the Vogel's Approximation Method (VAM) transportation model as an initial solution in solving transportation problems and the Modified Distribution (MODI) method as the final solution in solving transportation problems in transportation. The research obtained the results of the transportation costs of PT. Tirta Sukses Perkasa. The results showed that the minimum transportation costs at PT. Tirta Sukses Perkasa from September to December 2016 using the Vogel's Approximation Method as the initial solution and the Modified distribution (MODI) method, the value was Rp. 72,697,634.4. Where from the research it is concluded that the use of the transportation model in the distribution of goods has helped the company in finding the optimum solution, with a distribution cost that is smaller (minimum) when compared to before the use of the transportation model.

Based on the previous discussion, it becomes a basis for the author to conduct further research with the addition of a transportation solution method to compare the results of previous studies with the current one, then the title of this research is "Minimizing the transportation costs of shipping goods by applying the Stepping Stone and Modified Distribution (MODI) method. at PT. Tirta Sukses Perkasa".

LITERATURE REVIEW

Operations Research

Operations research is an application or system of various scientific methods that aims to describe the problems that arise in the direction and management of a large system (eg people, machines, materials and money) in the fields of industry, economics and business, governance and defense. The purpose of operations research is to assist decision makers in making scientific decisions and actions. Operations research has several characteristics (Mulyono, 2004), namely:

1. Interdisciplinary group approach to achieve optimum results
2. Using scientific research techniques to get optimum results
3. Only give a bad answer to a problem for which there is a worse answer
4. Does not provide a perfect answer to the problem, so operations research only improves the quality of the solution.

Linear Programing

In operations research there are several methods of solving one of them is linear programming (LP). Linear program is a mathematical model which in operations research technique is used to solve the optimal problem, namely by maximizing or minimizing the objective function which depends on a number of input variables. (Aminuddin, 2005), there is also a definition that says that linear programming is a

way to solve the problem of allocating limited resources among several competing activities, in the best way possible (Siti, 2018). The most important thing in this method is to find out the purpose of solving the problem and what the cause of the problem.

Some examples of situations from the description above include problems in terms of allocation such as allocation of production facilities and others, game solutions and selection of delivery patterns. And what characterizes all these situations is the necessity to allocate resources to activities. Linear programming is one of the most frequently used analytical methods in problem solving. A linear program uses a mathematical model to describe the problem to be solved. Basically the linear nature means that all mathematical functions in this model are linear functions. In other words, the definition of linear relationships means that when one factor changes, another factor changes by a constant amount proportionally (Haryadi, 2010).

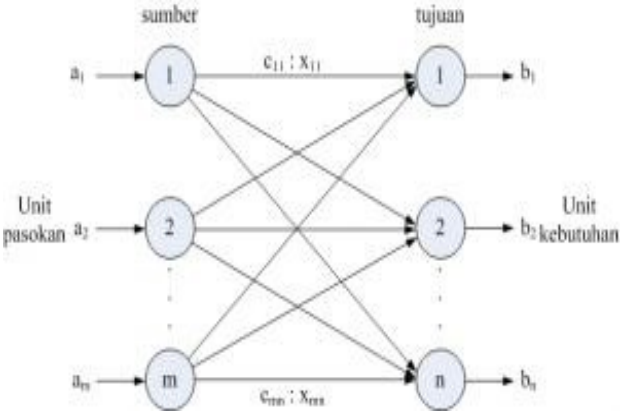
According to Subagyo (2005), in the linear programming model, some symbols that are often used to make it easier to solve a problem are as follows:

m = limitations of available resources or facilities
n = activities that use the resource or facility.
i = number of each source (eg, i=1,2.....n)
j = number of each activity (eg, j=1,2,3,.....n)
xj = activity level to, j(j=1,2,.....n)
aij = the number of resources i needed by the source to produce each unit of output of activity j (i=1,2.....m, and j=1,2,.....n).
bi = number of resources (facilities) i available to be allocated to each activity unit (i=1,2,...n)
Z = optimized value (maximum and minimum)
Cj = increase in the value of Z if there is an increase in the level of activity (xj) with units or is

Transportation Method

The transportation method is a special model of a linear programming problem that has to do with the allocation of a single commodity from a number of sources to a number of destinations. According to Zulfitri (2010) said that the transportation method is a method used to regulate the distribution of sources that provide the same product, to places that need it optimally. Dan Prasetyo (2011) transportation methods are a special group of linear programs that solve the problem of sending commodities from sources (factories) to destinations (warehouses).

Where the purpose of this method according to Prasetyo (2011) is to determine the delivery schedule by minimizing the total shipping costs by meeting supply and demand limits. Transportation applications can be developed in other areas of operation, such as inventory control, employee scheduling (employment scheduling), and personal assessment (personnel assignment). The examples of the transportation cycle described by Prasetyo (2011) are as follows



The purpose of a transportation model is to plan the delivery of a source (goods/product) to a destination, in such a way as to minimize the total cost of transportation with constraints (Nurjuliawati, 2013).

A transportation model is said to be balanced or a balanced program if the total amount between supply and demand is the same, where if it is formulated as follows:

$$\sum_{i=1}^{m} ai = \sum_{j=1}^{n} bj$$

So that a transaction model can be formulated as follows:

$$Z = \sum_{i=1}^{m} xij = \sum CijXij \quad \text{equal to}$$

$$\sum_{i=1}^{m} xij < \alpha i \; ; \; i = 1,2,3,.....m \text{ (offer limit)}$$

$$\sum_{i=1}^{m} xij < bj \; ; \; j = 1,2,3,.....m \text{ (request limit)}$$

$$Xij < 0$$

Transportation Problem Solving Method

The method of solving the problem of transportation is a method used to regulate the distribution of sources that provide the same product (supply) to locations or places that need (Demand) optimally. Transportation is concerned with determining the minimum or lowest cost plan to send an item from a number of sources or factories to a number of destinations or warehouses. According to Lolyta and Marihat (2014) transportation problems can be described in the form of a linear programming problem model, and one of the methods used to solve it is the simplex method.

a) Initial Solution

According to Rendy (2011), there are several stages that must be done to solve transportation problems, namely :

1. Determine the initial base feasible solution.
2. Determine the entering variable has met the conditions of the non-basic variables. When all variables have met the optimum conditions. STOP, if not, continue to step 3.
3. Determine the leaving variable among the existing base variables and then calculate the new solution. Go back to step 2.

There are several methods commonly used to determine the initial solution, namely:

West Corner

The initial allocation of values in cells is set in the cell at the far end of the top left of the table, the initial cell value depends on the supply demand demand constraints for the cell.

Minimum Cost Value

According to Fathiyya and I.Gede (2006) the minimum cost method is to systematically allocate the supply or demand as much as possible.

Vogel's Approximation Methode

In the process of determining the initial solution, VAM establishes the concept of a penalty (penalty cost). where the fine here is intended as the difference between the two smallest costs in cells that are in a row or column (Gerard, 2006).

b) Optimum Solution

Furthermore, after the three initial solutions are carried out above, the next thing to do is to determine the optimum solution of the transportation method, namely :

Stepping Stone

This method is used to manage the distribution of goods/products from sources (factories) that provide the same product, to destinations (warehouses) that require optimally. After the initial basic feasible solution has been obtained from the transportation problem, the next step is to reduce transport costs by including non-basic variables (i.e. allocation of goods to empty boxes) into the solution (Heizer and Render, 2005).

Modified Distribution

The MODI method is a variation of the stepping stone method based on the dual formulation. Unlike the stepping stone method, MODI does not need to specify all closed paths of nonbasic variables. Instead, the cij values are determined simultaneously and only the closed path for the entering variable is identified. This removes the tedious task of identifying all the stepping stone paths.

So we can conclude that the difference between these two methods lies in the steps used to solve problems where there is a closed trail to be traced. The operation of the MODI method in solving the problem of a transportation problem, the basic principle is the same as the other methods (Sasmito, 2010).

Conceptual Model

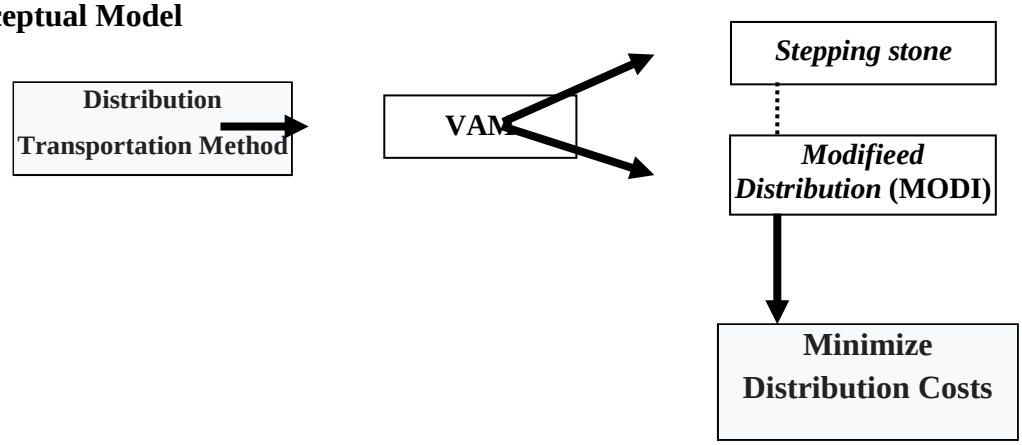


Figure 1 The Conceptual Model

RESEARCH METHOD

Location and Research Design

This research was conducted for ± 2 months using data from companies starting from September to October 2019. This research was carried out at PT. Tirta Sukses Perkasa Jl. Syech Yusuf, Kec. Rappocini, No. 10. Makassar, South Sulawesi.

Data Collection Method

In this study, the data collection technique used is in the form of documentation which is carried out by collecting all documents and company archives related to transportation and distribution problems.

Data Analysis Method

In this study, several analytical methods were used. The first method of analysis is the Vogel's Approximation method as an initial solution in knowing the minimum total cost, while the steps of this method are as follows:

a. Calculating Opportunity Cost for each row and column. Opportunity Cost is calculated for each row I by subtracting the smallest Cij value in that row from the Cij value one level greater in the same row. Then the opportunity cost column is obtained in a similar way. These costs are a penalty for not selecting the box with the minimum cost.
b. Choose the row or column with the largest opportunity cost (if there are twin values, choose arbitrarily). Then allocate as much as possible to the box with the minimum Cij value in the selected row or column. For the smallest Cij, Xij = minimum [Si,Dj]. This means that the biggest penalty is avoided.
c. Next, make adjustments between supply and demand to show the allocation that has been made. By eliminating all rows and columns where supply and demand has been exhausted.
d. If all supply and demand have not been met, go back to step 1 and calculate the new opportunity cost again. If all supply and demand, the initial solution has been obtained.

Then in this study the optimum solution used is the Stepping Stone method and Modified Distribution. The steps for these two methods are as follows:

Stepping Stone Method

1. Each empty box indicates a non-basic variable. For non-basic variables that will enter the solution, must contribute to the decrease in the value of the objective function.
2. Variable Xij is arbitrarily considered as a possible entering variable. Suppose it is decided to allocate 1 unit to the box.
3. Subtracting 1 from Xij produces a new value.

Modified Distribution Method

a) Determine the values of Ri for each row and values of Kj for each column by using the relationship cij = Ri + Kj for all base variables and assigning a value of zero to R1.
b) Calculate the change in cost, Cij, for each non-basic variable using the formula Cij = cij – Ri – Kj.
c) If there is a negative Cij value, the solution is not optimal. Select the Xij variable with the largest negative Cij value as the entering variable.
d) Allocate goods to the entering variable, Xij, according to the stepping stone process.
e) Go back to step 1.

RESULTS

Transportation Cost Optimization

In this study, two stages of initial solution were carried out to obtain the optimal value at PT. Tirta Sukses Perkasa in carrying out the distribution process, and as for each discussion about the initial solution will be discussed as follows:

Minimum Cost

PT. Tirta Sukses Perkasa is a company that has 2 factories making 240 ml club bottled water, namely those in Gowa and Takalar Regencies where the production capacity of each factory each month is 390,567 boxes (Gowa) and 330,689 boxes (Takalar). And with requests for each destination in 2019 as many as 453,283 boxes for the Syech Yusuf area, then Kima as many as 124,157 boxes, Maros as many as 18,108 boxes, Pangkep 29,794 boxes, Barru 42,123 boxes, Pare-Pare 53,791 boxes. Then the distribution allocation costs from each factory to the destination area are as follows:

	Average cost per delivery (in thousands of IDR) in 2019						
	Syech yusuf	**Kima**	**Maros**	**Pangkep**	**Barru**	**Pare-Pare**	**Supply**
Gowa	32163	11971	4761	4232	17464	32163	390567
Takalar	23729	9387	4706	38703	49208	48899	330689
Source 3	0	0	0	0	0	0	0
Source 4	0	0	0	0	0	0	0
Source 5	0	0	0	0	0	0	0
Source 6	0	0	0	0	0	0	0
Demand	453283	124157	18108	29794	42123	53791	721256

Data source processed 2021

Then as for the allocation of production results from each factory to the destination area with the lowest transportation costs by using trial and error in the POM QM application for Windows 4, as follows:

Iteration 1	Syech Yusuf	Kima	Maros	Pangkep	Barru	Pare-Pare
Gowa	264859	(-59)	(-84)	29794	42123	53791
Takalar	188424	124157	18108	(430)	(402)	(375)'
Source 3	(0)	(143)	(190)	(280)	(147)	(123)'
Source 4	(0)	(143)	(190)	(280)	(147)	(123)'
Source 5	(0)	(143)	(190)	(280)	(147)	(123)'
Source 6	(0)	(143)	(190)	(280)	(147)	(123)'

Data source processed POM QM for Windows 4

In the first allocation experiment, which was processed using the POM QM application for Windows 4, the lowest cost was not found because there were still several columns, namely 2, and 3 and in row 1 there were still negative values, where in the POM QM for Windows 4 application if the numbers were in If a column or row is under a minus sign and has a minus sign in front of it, the number is said to be negative. While the values in the columns and rows that are only preceded by a minus sign can be interpreted that in the column or row the allocation is reduced to find the desired alternative path. Then, because in the previous allocation there were still negative values, it was necessary to make another allocation, as shown in the following table :

Iteration 2	Syech Yusuf	Kima	Maros	Pangkep	Barru	Pare-Pare
Gowa	264859	(-59)	18108	29794	42123	53791
Takalar	188424	124157	(84)	(430)	(402)	(375)'
Source 3	(0)	(143)	(190)	(280)	(147)	(123)'
Source 4	(0)	(143)	(190)	(280)	(147)	(123)'
Source 5	(0)	(143)	(190)	(280)	(147)	(123)'
Source 6	(0)	(143)	(190)	(280)	(147)	(123)'

Data source processed POM QM for Windows 4

Furthermore, in the second allocation experiment in table, the lowest cost has not been found because in column 2 and row 1 there are still negative values, while in the POM QM for Windows 4 application rules if the number in a column or row is in the minus sign and also has a minus sign in front of it, the number is said to be negative and the condition for a good solution is if there are no more negative values in the column or row, so it needs to be allocated again, in the next table :

Iteration 3	Syech Yusuf	Kima	Maros	Pangkep	Barru	Pare-Pare
Gowa	264859	124157	18108	29794	42123	53791
Takalar	188424	(59)	(84)	(430)	(402)	(375)'
Source 3	(0)	(143)	(190)	(280)	(147)	(123)'
Source 4	(0)	(143)	(190)	(280)	(147)	(123)'
Source 5	(0)	(143)	(190)	(280)	(147)	(123)'
Source 6	(0)	(143)	(190)	(280)	(147)	(123)'

Data source processed POM QM for Windows 4

In the third allocation experiment, the lowest cost allocation was finally found because in all several columns and rows there were no more negative values, such as in the rules or conditions for a solution to a transportation problem that was declared optimal if there were no more negative values in the column or row, so that at the fourth experiment found a solution for the lowest cost allocation, and if it is described and interpreted as a whole, it is as follows:

Transportation Cost Allocation

Destination / Source	Syech Yusuf	Kima	Maros	Pangkep	Barru	Pare-pare	*Supply*
Gowa	(+) 322	(-) 120	(+) 48	(+) 42	(+) 175	(+) 199	390567
	122594 →	124157 →	18108 →	29794 →	42123 →	53791	
	237 ↑	94	47	387	492	489	330689

Takalar	330689	[59]	[84]	[430]	[402]	[375]	
Source C	…… [0]	…… [143]	…… [190]	… … … [280]	…… … [147]	…… … [123]	……
Source D	…… … [0]	…… … [143]	…… … [190]	… … … [280]	…… … [147]	…… … [123]	……
Source E	…… … [0]	…… … [143]	…… … [190]	… … … [280]	…… … [147]	…… … [123]	……
Source F	…… … [0]	…… … [143]	…… … [190]	… … … [280]	…… … [147]	…… … [123]	……
Demand	453283	124157	18018	29794	42123	53719	721256

Data source processed POM QM for Windows 4

Based on the table, the researcher conducted data analysis on the POM QM application for Windows 4, where the optimal results were found with a minimum in 2019, then the results in the table can be interpreted that in 2019 PT. Tirta Sukses Perkasa if you want to minimize transportation costs, from the factory located in Takalar, you have to send only 330689 boxes of 240 ml club bottled water to the Syech Yusuf area and from the factory in Gowa PT. Tirta Sukses Perkasa sent 240 ml club bottled water to the Syech yusuf area, totaling 122594 boxes, then the next destination was Kima, PT. Tirta Sukses Perkasa sends 240 ml club bottled water, only 124157 boxes are sent to the factory in Gowa, and 18108 boxes to the Maros area with the source/factory located in Gowa.

While in the Pangkep, Barru, and Pare-Pare areas, PT. Tirta Sukses Perkasa had to ship from the factory in Gowa as many as 29,794 boxes to the Pangkep area, 42123 boxes to the Barru area, and 53791 boxes to the Pare-Pare area, while the PT. Tirta Sukses Perkasa which is located in Takalar does not need to make deliveries so that the company will get a minimum cost in 2019.
So that the results of the minimum transportation costs during 2019 are :

$$Z = \sum_{i=1}^{2} \sum_{j=1}^{6} CiCj$$

= C2.1+C1.1+C1.2+C1.3+C1.4+C1.5+ C1.6

= 2372.1 + 3221.1 + 1201.2 + 481.3 + 421.4 + 1751.5 + 1991.6

*= (237x330689) + (322x*122594*) + (120x*124157*) + (48x*18108*) + (42x*29794*) + (175x*42123*) + (199x*53791*)*

= 78.373.293 + 39.475.268 + 14.898.840 + 869184 + 1.251.348 + 7.371.525 + 10.704.409

= Rp. 152.943.900

So the results obtained from the initial solution on distribution costs in 2019 at PT. Tirta Sukses Perkasa is **Rp 152,943,900**.

Final Solution (Modi)

Before further optimization testing is carried out, the number of cells that are met must meet the requirements = $(m+n)-1=(2+6)-1=7$. This means that the conditions are met (see table 13). Furthermore, as the optimum solution to produce the minimum total transportation costs at PT. Tirta Sukses Perkasa used the Modified Distribution (MODI) method with the following procedure:

a. Calculate the index value in each row and column, using the formula $+Kj=C$, where is the index value in row is the index value in column and is the distribution cost from source to destination . The value of this index must be based on cells that have been filled or used. As a tool to start looking for index values, the first row value ($R1$) is set equal to zero.

b. Use the formula ($Ri+Kj=Cij$) to get the index value of all rows and columns.

$R1= 0$

$R1+K1=C1.1$ ➡ $0+K1 = 322$ ➡ $K1 = 322$

$R1+K2=C1.2$ ➡ $0+K2 = 120$ ➡ $K2 = 120$

$R1+K3=C1.3$ ➡ $0+K3 = 48$ ➡ $K3 = 48$

$R1+K4=C1.4$ ➡ $0+K4 = 42$ ➡ $K4 = 42$

$R1+K5=C1.5$ ➡ $0+K5 = 175$ ➡ $K5 = 175$

$R1+K6=C1.6$ ➡ $0+K6 = 199$ ➡ $K6 = 199$

$R2+K1=C2.1$ ➡ $R2+322=237$ ➡ $R2 = -85$

Transportation Cost Allocation

Destination / Source	Syech Yusuf =322	Kima =120	Maros = 48	Pangkep =42	Barru =175	Pare-pare =199	*Supply*
Gowa = 0	(+) 322 122594	(-) 120 124157	(+) 48 18108	(+) 42 29794	(+) 175 42123	(+) 199 53791	390567
Takalar = -85	237 330689	94	47	387	492	489	330689
Demand	453283	124157	18018	29794	42123	53719	721256

c. Look for empty cells or cells that have not been filled and then shaded using yellow all rows and columns.

d. Calculate the value in the blank cells using the formula ($Iij=Cij-Ri-Kj$).

$I1.2=C2.2-R2-K2=94-(-85)-120=59$

$I1.3=C2.3-R2-K3=47-(-85)-48 = 84$

$I2.4=C2.4-R2-K4=387-(-85)-42 = 430$

$I2.5=C2.5-R2-K5=492-(-85)-175=402$

$I2.6=C2.6-R2-K6=489-(-85)-199=375$

Because no negative value (cost savings) was found in the calculation of empty cells, it means that the optimum solution has been obtained.

Transportation Cost Allocation							
Destination / Source	Syech Yusuf =322	Kima =120	Maros = 48	Pangkep =42	Barru =175	Pare-pare =199	*Supply*
Gowa = 0	(+) 322 122594	(-) 120 124157	(+) 48 18108	(+) 42 29794	(+) 175 42123	(+) 199 53791	390567
Takalar = -85	237 330689	94 59	47 84	387 430	492 402	489 375	330689
Demand	453283	124157	18018	29794	42123	53719	721256

e. After all the empty cells have no negative values, then the minimum total cost distribution is calculated using the equation.

$$\sum_{i=1}^{2}\sum_{j=1}^{6} CiCj$$

$= C_{1.1}+C_{1.2}+C_{1.3}+C_{1.4}+C_{1.5}+C_{1.6}+ C_{2.1}+C_{2.2}+C_{2.3}+C_{2.4}+C_{2.5}+C_{2.6}$

$= 322_{1.1} + 120_{1.2} + 48_{1.3} + 42_{1.4} + 175_{1.5} + 199_{1.6} + 237_{2.1} + 94_{2.2} + 47_{2.3} + 387_{2.4} + 492_{2.5} + 489_{2.6}$

$= (322x122594) + (120x124157) + (48x18108) + (42x29794) + (178x42.123) + (199x53.791) + (237x330689) + (94x59) + (47x84) + (387x430) + (492x402) + (489x375)$

$= 39.475.268 + 14.898.840 + 869.184 + 1.251.348 + 7.497.894 + 10.704.409 + 78.373.293 + 5.546 + 3.948 + 166.410 + 197.784 + 183.375$

$= Rp.\ 153.627.300$

After testing to find the optimum solution using the Modified Distribution (MODI) method in 2019 at PT. Tirta Sukses Perkasa, cost of Rp 153,627,300 was obtained.

DISCUSSION

The data obtained at PT. Tirta Sukses Perkasa, obtained a different total cost in the distribution of goods from the factory to the distribution destination for 240 ml AMDK Club from January to December 2019, which was Rp. 301,742,749. Then to get the minimum total cost of distribution at PT. Tirta Sukses Perkasa used the Vogel's Approximation Method (VAM) to Stephing stone as the initial solution and the Modified Distribution (MODI) method as the optimum solution. From the results of the study, the transportation costs incurred by PT. Tirta Sukses Perkasa in the initial solution using the Vogel's Approximation Method (VAM) Vogel's Approximation Method (VAM) method to Stephing stone in January-December 2019 cannot be concluded that the results are already minimum, so followed by using the MODI method.

After using the MODI method, the results of the minimum transportation costs in January – December 2019 were obtained at a cost of Rp. 153,627,300. Where the results of the research conducted there are differences in distribution costs, where the costs incurred by PT. Tirta Sukses Perkasa in January to December 2019 amounted to Rp. 301,742,749. After doing the research, the result of the minimum transportation

cost is Rp. 153.627.300. Where the results obtained after conducting research are more minimal with a difference of Rp. 148,115,449. So the results obtained by using the Modified Distribution (MODI) method as the optimum solution, are already optimum with smaller results than before this method was used.

CONCLUSION

The conclusion from the results of this study is that the average transportation costs at PT. Tirta Sukses Perkasa for 1 year starting from January to December 2019 using the Modified Distribution (MODI) method, which is Rp. 153,627,300. Where these results are much more efficient when compared to costs before using transportation problem solving (MODI).

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