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Analysis Of The Application Of The Transport Model With Least Cost Method (case study at PT.SI)

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Abstract. Transport problems related to the distribution of goods and services from various production centers to several points of sale. Distribution plays an important role because without the right distribution model, the distribution process can take a high cost and a relatively long time. In this study using the least cost method where its use is based on rules or normative allocation of supply and resource needs in a transport matrix without calculating the economic magnitude, from the results of this study, the cost of Minimum shipment is IDR 325,050,000 with consolidated delivery as follows because Tangerang factory ships to Balikpapan, Cirebon and Palembang cities. For Karawang factory to send products to Jakarta city, Surabaya, Bali, Yogyakarta and Cirebon Meanwhile, the Sidoarjo factory ships products to the cities of Surabaya and Makassar.

1 Introduction

The problem of the distribution of goods is an aspect that must be considered because these problems have a considerable influence on the costs and the level of service to consumers. Several obstacles must be encountered in the distribution process, such as the number of different goods requests for each consumer, the capacity of vehicles, the delivery time, the average speed that can be reached on certain routes and certain times and different places of consumption. Therefore, we need a way for the distribution process to run smoothly and on time with minimal production costs.

PT. SI is a company in the consumer goods sector, which offers several types of products sold throughout Indonesia and imported from abroad. To be able to meet the needs of the market, the company has many distributors as distributors of products to retailers. These distributors (destination) are distributed throughout Indonesia which are located in several points in major cities, namely in the cities of Jakarta (1), Surabaya (2), Bali (3), Makasar (4), Yogyakarta (5), Balikpapan (6), Cirebon (7) and Palembang (8). Each distributor will source products from factories (sources) located in Tangerang, Karawang and Sidoarjo.

Each month each factory has its own production capacity, which is to meet the needs of consumers at different distributors. When sending products to distributors, there are costs that must be borne by the company, where the further the distributor is located, the higher the costs that must be borne by the company. Therefore, a transportation method is used to obtain optimal shipping costs to each distributor where all the distributor's needs can be met by the 3 existing factories.

From the description of the problem above, one way to overcome a distribution of goods is to use the transport method. The case of transportation arises when someone determines the mode of delivery (distribution) of one type of product (goods) or more from multiple sources to multiple consumers (demand) that can minimize costs. The goal of this transportation problem is to allocate goods at source until all needs

are satisfied at the consumer (demand location) with minimum production costs. The mode of transportation as an effort to distribute goods is such that supplies from multiple sources can be made efficiently with minimal costs to multiple destinations (consumers).

2 Literature review

Transportation methods are used to organize distribution from sources that supply the same product to places that need it. There are several methods to find a feasible initial base solution, namely North West Corner, Least Cost and Vogel Approximation. Meanwhile, there are two methods to check optimally, namely Stepping Stone and MODI (Modifield Distribution). Allocation of this product should be arranged in this way, as there are cost differences from one source to a different destination.[1]

The supply or maximum supply for each source is the minimum demand for each destination. This distribution is done in such a way that requests from multiple locations can be fulfilled from multiple sources, each of which may have different requirements or capabilities. This distribution is made taking into account the variable transport costs due to the different distances and conditions between the locations. By using the method of transportation, a breakdown of the distribution of goods can be obtained which can minimize the total cost of transportation.

This mode of transportation is used when someone determines the mode of delivery (distribution) of a type of commodity from multiple sources (places of supply) to multiple destinations (places of demand) that can minimize costs. The objective of this transport problem is to allocate the existing goods at the source so that all the needs are met at the location of the demand. The purpose of using the transportation method as a commodity distribution effort is so that supplies from multiple sources can be made efficiently with minimal costs to multiple demand locations.

2.1 Transportation method

The mode of transport concerns the distribution of the same product from several sources with a limited supply, to several destinations, with a certain demand, at minimum distribution costs. Because there is only one type of good, a destination can meet its demand from one or more sources. To obtain minimum costs, the distribution of products must be organized in this way, since there are differences in the costs of distribution, both from source to destination or vice versa.[2]

Basically, the transportation problem is a group in a linear program that can be solved using the simplex method. However, due to its particular aspect, the transport problem requires more practical and efficient calculation methods. The transport problem has several characteristics, among others:

1. There are a number of sources and a number of specific destinations.
2. The quantity or quantity of goods distributed from each source and demanded by each destination is certain.
3. The quantity or quantity of goods sent from a source to a destination in accordance with the source's demand or capacity.
4. The cost of transportation from a source to a destination is certain.

The transport method is a method used to regulate the distribution from sources that supply the same product to places that need it optimally at the least cost. The allocation of this product must be organized in this way because there are differences in the costs of allocating from one source or from several sources to different destinations.

2.2 Transportation models

The transport model is an image that is in the form of a mathematical model of a transport case that can help to think quickly and systematically about the case.[3]

Transport issues can be placed in a special table called the transport table. Sources are listed in rows and destinations in columns. In the transport table, there are $m \times n$ boxes. Transport costs per unit of goods C_{ij} are recorded in a small box at the top right of each box. Demand from each destination is listed on the bottom row, while supply from each source is recorded on the far right column. The bottom left corner box shows the fact that the bid or offer (S) is the same as the ask or demand (D). The variable X_{ij} in each box indicates the quantity of goods transported from source i to destination j . The general form of the transportation table can be seen in Table 2.1 below.

Table 1. Transport model matrix

Ke Dari	A	B	...	n	Demand
1	X_{1A} C_{1A}	X_{1B} C_{1B}	...	X_{1n} C_{1n}	b_A
2	X_{2A} C_{2A}	X_{2B} C_{2B}	...	X_{2n} C_{2n}	b_B
⋮	⋮	⋮	⋮	⋮	⋮
m	X_{mA} C_{mA}	X_{mB} C_{mB}	...	X_{mn} C_{mn}	b_n
Supply	a_A	a_B	...	a_m	Σa
					Σb

The general form of the transport model can be described as a transport matrix. A matrix with n rows and m columns. In the transport matrix, sources are located in rows, while destinations are located in columns. The i notation is used to mark the i -th row, while the j notation is used to mark the j -th column. Or:

X_{ij} = the number of units of product or goods to be sent from the i th source to the j th destination

C_{ij} = cost of transporting goods per unit from source i to destination j

a_i = number of goods supplied or capacity of source i

b_j = number of goods requested or ordered per destination j

m = number of sources

n = the number of goals

A transport problem is said to be balanced (balanced schedule) if the total supply at source i is equal to the number of demands at destination j .

2.3 Least cost method

The least cost method performs a systematic allocation of boxes based on the minimum transportation cost. The steps of this method are:

1. Select the box with the smallest transport cost (C_{ij}) then allocate as much supply or demand as possible. For the smallest C_{ij} , X_{ij} = minimum [S_i , D_j] which will occupy row i or column j . Row i or column j that was used will be deleted.
2. Of the remaining squares (the squares that were not removed), select the smallest C_{ij} again and allocate as many as possible in row i or column j .
3. This process will continue until supply and demand are met

3 Result and discussion

Here is the data of shipping cost, distributor requirement and factory production capacity in 1 day which occurs in PT SI, where there are 3 factories, namely Tangerang factory, Karawang factory and Sidoarjo factory with 6 destinations namely Jakarta, Surabaya, Bali, Makassar, Yogyakarta, Balikpapan, Cirebon and Palembang.

Table 2 Delivery and production data

Destination Source	Pabrik Tangerang (1)	Pabrik Karawang (2)	Pabrik Sidoarjo (3)	DEMAND
Jakarta (1)	Rp 3.800	Rp 1.500	Rp 4.000	750 ctn
Surabaya (2)	Rp 3.500	Rp 1.800	Rp 2.100	1350 ctn
Bali (3)	Rp 8.300	Rp 2.300	Rp 6.400	950 ctn
Makasar (4)	Rp 8.500	Rp 8.800	Rp 7.000	1200 ctn
Yogyakarta (5)	Rp 5.300	Rp 2.300	Rp 3.200	450 ctn
Balikpapan (6)	Rp 5.800	Rp 8.800	Rp 7.700	1600 ctn
Cirebon (7)	Rp 1.800	Rp 3.300	Rp 4.200	2700 ctn
Palembang (8)	Rp 2.500	Rp 4.500	Rp 4.400	1000 ctn
SUPPLY	5000 ctn	3000 ctn	2000 ctn	

Table 3. Table of optimal shipping costs

Pabrik	Distributor	Pengiriman (karton)	Biaya Pengiriman (per karton)	Total Biaya Pengiriman
Tangerang	Balikpapan	1600	Rp 5.800,-	Rp 9.280.000,-
	Cirebon	2400	Rp 1.800,-	Rp 4.320.000,-
	Palembang	1000	Rp 2.500,-	Rp 2.500.000,-
Karawang	Jakarta	750	Rp 1.500,-	Rp 1.125.000,-
	Surabaya	550	Rp 1.800,-	Rp 990.000,-
	Bali	950	Rp 2.300,-	Rp 2.185.000,-
	Yogyakarta	450	Rp 2.300,-	Rp 1.035.000,-
Sidoarjo	Cirebon	300	Rp 3.300,-	Rp 990.000,-
	Surabaya	800	Rp 2.100,-	Rp 1.680.000,-
	Makasar	1200	Rp 7.000,-	Rp 8.400.000,-
Grand Total Biaya Pengiriman				Rp 32.505.000,-

From the data above, the POM for Windows application is used with the transport model. Here is the company input data:

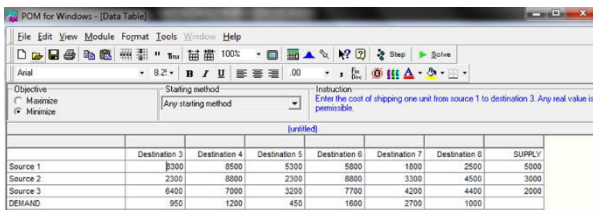


Figure 1. Data Entry in POM for Windows

The row is the sources, which means the availability of factories with different capacities, while the column is the destination, which means the location of the distributor that has a different number of requests, while the column is the costs of shipment (RP). the results of the following analysis are the results of calculations using the POM software for Windows.

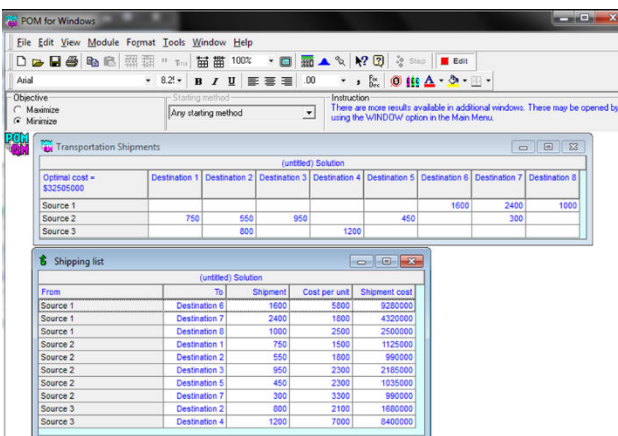


Figure 2. Results of data optimization

From the image above, the minimum shipping cost is IDR 325,050,000 with shipping details as follows:

The Tangerang factory ships products to the cities of Balikpapan, Cirebon and Palembang. The Karawang factory ships products to the cities of Jakarta, Surabaya, Bali, Yogyakarta and Cirebon. Meanwhile, the Sidoarjo factory ships products to the cities of Surabaya and Makassar. These results are shipping costs per day with every day each factory has a different delivery destination, because every day the number of needs of each city is also different, but the shipping costs are a fixed cost. Thus, by using the POM software for Windows daily with the transport model, the company can distribute products according to the needs and minimum costs.

4 Conclusion

From the results of this study, it appears that the minimum shipping cost is IDR 325,050,000 with the following shipping grouping for Tangerang factory sending products to Balikpapan, Cirebon and Palembang cities. The Karawang factory ships products to the cities of Jakarta, Surabaya, Bali, Yogyakarta and Cirebon. While Sidoarjo factories send products to Surabaya and Makassar cities, these results are shipping costs per day with every day every factory has different delivery destination, because every day the number of needs of each city is also different, but the shipping cost is a fixed cost and the most minimum cost.

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