# Zack Algorithm: A Heuristic Approach to Solve Transportation Problem

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## Abstract

The problem of distribution is a classic problem in logistics. The transportation method is a method that is widely used in overcoming these problems. The optimization method is sometimes difficult if directly applied to minimize transportation costs so that the initial solution that is heuristic in nature is needed first even more so if there are many variables. A good initial solution is one that is easily done quickly and approaches the optimal solution. This research offers a new method of finding an initial solution called Zack Algorithm which only has 5 steps that are easy to do. Based on the case study carried out, Zack Algorithm produces the lowest cost which is 0.28% lower than the North West Corner method and 0.15% lower than the Least Cost method.

## Keywords
Logistics, Transportation, Heuristic, Least Cost, Zack Algorithm

## 1. Introduction

The problem of distribution of goods from certain locations to the destination is a classic problem in logistics. The allocation of a product must be arranged in such a way as to minimize the total cost of transportation (transportation), with the constraints of each request being fulfilled, and the source may not send commodities greater than capacity (Arifin, 2010).

The transportation model is included in the linear program problem so that it is useful to find optimal solutions where the numerical function consists of one or more variables that are faced with obstacles (Teguh, 2014). However, sometimes it is difficult to directly use the optimization method to get the optimal solution so that the initial solution is needed first. Even more so if there are many variables.

There are several initial solutions to transportation problems. Some of the most famous are the North West Corner (NWC) and Least Cost (LC) methods. Both methods still have disadvantages. The disadvantage of the NWC method is that it does not allocate as many products as possible to the cell box that has the smallest transportation costs. In other words, each product allocation does not pay attention to the amount of the cost per unit. Because it does not pay attention to unit costs, the NWC method is less efficient and is the longest method in finding the optimum table (Yusanti et al., 2017). The disadvantage of the LC method lies in determining the allocation of products into cells or boxes that have the lowest costs, where the costs have more than one cell so that it confuses users because there are no rules in choosing. Therefore, we need a method that can accommodate the shortcomings of the initial solutions.

The main key in finding an initial solution to the transportation problem is that it is easy to do and results are close to optimal. The goal is when proceeding to the optimization process is quicker to find the optimal solution. In this study, researchers offered an initial solution called Zack Algorithm. Zack Algorithm has an algorithm that is easy to understand and faster to do than other initial solutions. Zack Algorithm can also fill the shortcomings of the NWC and LC methods so that it is expected to be able to help especially in overcoming transportation problems.

## 2. The Algorithm of Proposed Method

In this section the researchers proposed a Zack Algorithm to find an initial solution to the transportation problem. Basically, the main principle of Zack Algorithm is to fill in the number 0 in the cell that has the highest cost and fill the maximum amount in the cell that has the lowest cost. The steps of it are given below:

1. Select the cell (Xij) with the highest cost (Cij) and fill the cell with the number 0.
2. In line i, select the cell that has the lowest cost and fill the delivery capacity with the maximum amount
3. In column j, select the cell that has the lowest cost and fills the delivery capacity with the maximum amount. If there is more than 1 cell that has the lowest cost, then select the cell that can be filled with the largest amount (applies to rows and columns).
4. If there are still cells left, fill the deficiency in the cell that has the lowest cost with the maximum number and so on.
5. Calculate the total transportation costs using equation 1.

$$\text{Total Cost} = \sum_{i=1}^{m} \sum_{j=1}^{n} CijXij \quad (1)$$

Zack Algorithm fulfills the main key in finding an initial solution that is easy and fast which only has 5 steps. Next will be given a case study on transportation problems using Zack Algorithm which will later be compared with the NWC and LC methods to find the minimum cost.

## 3. Results and Discussion

### 3.1 Case Study

An Ugih company has 4 shoe production factories which will be distributed to 4 retail warehouses. The factories have a production capacity each week where W factory with a capacity of 225, H plant with a capacity of 175, factory P with a capacity of 300, and plant J with a capacity of 275. Whereas, the demand from each warehouse is 300 with a warehouse A, 300 with B with 150, warehouse C as many as 200, and warehouse D as much as 325. The transportation costs (in Rp x 100) needed to deliver shoes from the factory to the retail warehouse are shown in Table 1.

Table 1. Transportation Table

| | Warehouse A | | Warehouse B | | Warehouse C | | Warehouse D | | Factory Capacity |
|---|---|---|---|---|---|---|---|---|---|
| Factory W | $X_{11}$ | 20 | $X_{12}$ | 5 | $X_{13}$ | 8 | $X_{14}$ | 6 | 225 |
| Factory H | $X_{21}$ | 15 | $X_{22}$ | 20 | $X_{23}$ | 10 | $X_{24}$ | 12 | 175 |
| Factory P | $X_{31}$ | 25 | $X_{32}$ | 10 | $X_{33}$ | 19 | $X_{34}$ | 21 | 300 |
| Factory J | $X_{41}$ | 15 | $X_{42}$ | 22 | $X_{43}$ | 15 | $X_{44}$ | 13 | 275 |
| Demand | 300 | | 150 | | 200 | | 325 | | 975 |

### 3.2 Zack Algorithm Method

The following are the steps in completing the case study above using Zack Algorithm:

1. The biggest cost is in cell X31 so fill X31 with 0.
2. In the 3rd row, the lowest cost is in cell X32 so that it is filled with a maximum of 150

3. In column 1 with the lowest cost in cells X21 and X41 then select what can be filled with the maximum amount, that is, X41 with the maximum capacity of 275
4. There is still capacity left, the cell with the lowest cost is in cell X14, fill with the maximum amount of 225. There is still capacity remaining, the cell with the lowest cost is in cell X23, fill with the maximum number of 150 because in X21 it needs to be filled in 25, and the rest adjust.
5. Total transportation costs can be calculated using equation 1 so that a total cost of Rp. 11900 x .100 = Rp. 1,190,000.

The results of the transportation table that have been filled in using Zack Algorithm can be seen in Table 2.

Table 2. Zack Algorithm Calculation Results

| | Warehouse A | | Warehouse B | | Warehouse C | | Warehouse D | | Factory Capacity |
|---|---|---|---|---|---|---|---|---|---|
| Factory W | 0 | 20 | 0 | 5 | 0 | 8 | 225 | 6 | 225 |
| Factory H | 25 | 15 | 0 | 20 | 150 | 10 | 0 | 12 | 175 |
| Factory P | 0 | 25 | 150 | 10 | 50 | 19 | 100 | 21 | 300 |
| Factory J | 275 | 15 | 0 | 22 | 0 | 15 | 0 | 13 | 275 |
| Demand | 300 | | 150 | | 200 | | 325 | | 975 |

### 3.3 Comparison of Proposed Methods with NWC and LC

Zack Algorithm calculation results on the above problems will be compared with the NWC and LC methods. The NWC Method rule is to burden as much as possible to the maximum limit of supply or need (which is achieved first) in the allocation matrix at the top left and continue to the bottom right so that all needs for resources can be met (Chandra, 2016). Whereas the LC method is the priority allocation which has the smallest unit cost (the smallest cost per unit). The initial allocation is in the box in the table that has the lowest cost (Nelwan et al., 2013). The calculation results of the NWC method are in Table 3 and the results of LC methods are in Table 4. A comparison of the results of the calculation of the total cost of the three methods for solving the initial solution to the problem above is recapitulated shown in Table 5.

Table 3. NWC Calculation Results

| | Warehouse A | | Warehouse B | | Warehouse C | | Warehouse D | | Factory Capacity |
|---|---|---|---|---|---|---|---|---|---|
| Factory W | 225 | 20 | 0 | 5 | 0 | 8 | 0 | 6 | 225 |
| Factory H | 75 | 15 | 100 | 20 | 0 | 10 | 0 | 12 | 175 |
| Factory P | 0 | 25 | 50 | 10 | 200 | 19 | 50 | 21 | 300 |
| Factory J | 0 | 15 | 0 | 22 | 0 | 15 | 275 | 13 | 275 |
| Demand | 300 | | 150 | | 200 | | 325 | | 975 |

Table 4. LC Calculation Results

| | Warehouse A | | Warehouse B | | Warehouse C | | Warehouse D | | Factory Capacity |
|---|---|---|---|---|---|---|---|---|---|
| Factory W | 0 | 20 | 150 | 5 | 0 | 8 | 75 | 6 | 225 |
| Factory H | 0 | 15 | 0 | 20 | 175 | 10 | 0 | 12 | 175 |
| Factory P | 300 | 25 | 0 | 10 | 0 | 19 | 0 | 21 | 300 |
| Factory J | 0 | 15 | 0 | 22 | 25 | 15 | 250 | 13 | 275 |
| Demand | 300 | | 150 | | 200 | | 325 | | 975 |

Table 5. Comparison Results of the Three Methods

| | Zack Algorithm | North West Corner | Least Cost |
|---|---|---|---|
| Total Cost (Rp) | 1.190.000 | 1.655.000 | 1.407.500 |

Based on the comparison of the total cost, it can be seen that the Zack Algorithm has the lowest total cost compared to the NWC and LC methods. The total cost of the Zack Algorithm is 0.28% lower than the NWC method and 0.15% compared to the LC method.

## 4. Conclusions

Zack Algorithm is a new method in solving initial solutions to transportation problems. The basic principle is to fill in the number 0 in the cell that has the highest cost and fills the maximum amount in the cell that has the lowest cost. In the case study described above, it is known that the Zack Algorithm is better than the NWC and LC methods because it produces the lowest total cost where the total cost of the Zack Algorithm is 0.28% lower than the NWC method and 0.15% compared to the LC method. However, because Zack Algorithm is a heuristic method, it does not rule out the possibility that other problems will produce a greater total cost than other methods. At least in this research, a new method is found in finding initial solutions that are easily and quickly done.

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## Biography

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