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Shipping Cost Optimization Using Least Cost and Stepping Stone Method at The Xender Brand Sandal Factory

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Abstract. The optimization model is one of the system analysis models identified with operation research. The transportation model determines the lowest cost for sending one item from several sources to several destinations as a collection of interconnected elements forming a single unit to integrate data, process, and store. Goods delivery transportation services are the use of software to provide services in the form of delivery of goods that are interrelated and structured to achieve a specific goal. The working principle of the Least cost method is to prioritize allocations with the most negligible unit cost (most minor cost per unit). This research was carried out using the Least Cost method so that companies can determine the optimal cost of shipping goods.

Keyword: Transportation, Least Cost, Stepping Stone

1. Introduction

Along with the development of e-commerce services received by companies in Indonesia that dominate the search for product information and online shopping or e-commerce in Indonesia, which benefits other parties, especially cost-effective goods delivery services, goods delivery services will deliver goods for sale to buyers. With forwarding services, delivery requests become more accessible, the distance between buyers and sellers becomes infinitely farther, and shipping services can solve distance problems [1].

Shipping issues relate to shipping goods from multiple sources to multiple destinations—usually, more freight from each source and cargo capacity requirements from each destination. The main problem in product allocation is how to get the product through channels, in particular, from the source of the product to the destination so that the costs incurred can be kept to a minimum. Transporting products can be optimal if it is supported by proper distribution planning so that it will cause minimum

shipping costs. While the main objective of the transportation problem is to achieve the lowest possible cost (minimum) or generate maximum profit (maximum) [2].

The transportation problem is part of "operation research," which discusses minimizing transportation costs from one place to another. The case of transportation arises when someone tries to determine how to send (distribute) a type of goods from several sources (locations of supply) to several destinations (locations of demand) [3]. For this reason, companies must be able to manage operational costs, which are used between company expenses and income. The greater the range between income and expenditure, the greater the profit obtained in the hope that income is more significant than expenditure.

The object of research in this paper is the Xender brand sandal factory. In this process, the amount of production and the number of requests will influence each other. In this case, the author uses the initial solution of the Least Cost method because it, in its calculations, pays close attention to how much it costs to send each source to the destination. The least Cost method, in some instances, can be a minimum solution [4]. This initial solution must be tested again with a minimum solution, namely using the Stepping Stone method [5].

The problem in this research is to minimize the cost of distributing sandal products from factories to warehouses to shops in Bandung, Jakarta, Tangerang, and Medan according to the requests from the agents or stores. The data used in this study consisted of primary data and secondary data. Primary data includes distance, time, and cost data. While secondary data includes agent or shop demand data and supply data from factories and warehouses. By ignoring the length of time, it takes for distribution from factory to warehouse to shops or agents and employee salaries. This research was conducted in two stages, namely the first to find the initial solution by determining the minimum value using the Least Cost method. Then these results were tested in the second stage, namely finding the minimum solution to determine the minimum value using the Stepping Stone method. This study aims to compare the Least Cost and Stepping Stone methods to minimize distribution costs and manage the distribution process at the Xender brand sandals factory.

2. Literatur Review

2.1. Least Cost Method

When using the least or lowest cost method, solving the initial transportation problem is to allocate the highest possible number of commodities to the cell with the most negligible unit cost in the entire table. If several cells have the exact most negligible unit cost, choose one of them equally [4]. Cross the filled column or row; if both columns and rows are filled simultaneously, only one is crossed. After adjusting the supply and demand for all uncrossed rows and columns, repeat the process assigning the highest possible value to the cell with the following most minor uncrossed unit cost [6]. This procedure is completed when precisely one row or column has not been crossed out [7].

2.2. Transportation Method

The transportation method optimizes distribution from sources that provide the same product to places that need it. The allocation of this product must be arranged in such a way because there are differences in allocation costs from one source to a destination. The case of transportation arises when a company tries to determine the method of delivery (distribution) of a type of goods (item) from several sources (locations of supply) to several destinations (locations of demand) that minimize costs [8][2]. The data

analysis method used to solve the problem uses the transportation method. For initial solutions using the upper left corner lower right corner method (North West Corner Method), the least cost method (Least Cost Method), VAM (Vogel's Approximation Method), and optimal testing using the stepping stone method (Stepping Stone Method) and MODI (Modified Distribution) [7].

2.3. Stepping Stone

As described by Heizer and Render (2001) in the journal (Siswati, 2012) [9] states that the stepping stone method can help us move from a feasible solution to an optimal solution. The stepping stone method evaluates cost-effectiveness starting from transporting goods through transportation routes outside the solution [5]. The results obtained from data processing using the North West Corner (NWC) method are feasible solutions. Furthermore, data processing is carried out using the stepping stone method to select optimal allocations so that transportation costs become more economical [10].

3. Method

Data collection occurred in the Waru sub-district, Surabaya, at the Xander sandal factory on December 5, 2022, with direct observation with the factory owner. This place was chosen because the mobilization of goods sent is relatively high, so conducting research using the least cost method is appropriate. The method used in this research is direct observation by collecting data and information in the form of direct data from factory owners. The method used in this study is the least cost and stepping stone method.

Table 1. Supply And Demand Data of Sandals on The Xander Factory

SUPPLY		DEMAND	
City	Supply/day	City	Demand/day
Sidoarjo	700	Bandung	120
Mojokerto	200	Jakarta	460
		Tangerang	240
		Medan	80

Tabel 2. Sandals Transportation Costs at Xander's Factory

Distribution Route	Transportation Costs (IDR)	
	Sidoarjo	Mojokerto
Bandung	12500	11000
Jakarta	13000	12000
Tangerang	13000	12000
Medan	15000	15300

4. Result and Discussion

The use of sections to divide the text of the paper is optional and left as a decision for the author. Where the author wishes to divide the paper into sections the formatting shown in table 2 should be used.

4.1. Least Cost Calculation

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The Least Cost method is a method that fills the boxes that have the most minor transportation costs. If there is more than one box with the most minor transportation cost, the box with the largest allocation is selected first [4].

Table 3. *Iteration 1*

LC		DEMAND				Supply
		Bandung	Jakarta	Tangerang	Medan	
SUPPLY	Mojokerto	11000 120	12000	12000	15300	200
	Sidoarjo	12500	13000	13000	15000	700
Demand		120	460	240	80	900

Table 4. *Iteration 2*

LC		DEMAND				Supply
		Bandung	Jakarta	Tangerang	Medan	
SUPPLY	Mojokerto	11000 120	12000 80	12000	15300	200
	Sidoarjo	12500	13000	13000	15000	700
Demand		120	460	240	80	900

Table 5. *Iteration 3*

LC		DEMAND				Supply
		Bandung	Jakarta	Tangerang	Medan	
SUPPLY	Mojokerto	11000 120	12000 80	12000	15300	200
	Sidoarjo	12500	13000 380	13000	15000	700
Demand		120	460	240	80	900

Table 6. *Iteration 4*

LC		DEMAND				Supply
		Bandung	Jakarta	Tangerang	Medan	
SUPPLY	Mojokerto	11000 120	12000 80	12000	15300	200
	Sidoarjo	12500	13000 380	13000 240	15000	700
Demand		120	460	240	80	900

Table 7. *Iteration 5*

LC	DEMAND				Supply
	Bandung	Jakarta	Tangerang	Medan	

SUPPLY	Mojokerto	11000	12000	12000	15300	200
		120	80			
	Sidoarjo	12500	13000	13000	15000	700
			380	240	80	
Demand		120	460	240	80	900

In Iteration 1, the smallest cost is chosen, namely 11,000 with a total demand of 120, then in Iteration 2, the smallest cost is 12,000 with a total remaining supply of 80. In Iteration 3, the smallest cost is 13,000 with a total demand of 380. In Iteration 4, the smallest cost is 13,000 with a total demand of 240. And in Iteration 5, the smallest cost is 15,000 with a total supply of 80.

Table 8. Total Cost

COST						
BASIS		SUMMARY				
1	S1D1	11000	X	120	=	1320000
2	S1D2	12000	X	80	=	960000
3	S2D2	13000	X	380	=	4940000
4	S2D3	13000	X	240	=	3120000
5	S2D4	15000	X	80	=	1200000
TOTAL						11.540.000

In the table above, it can be seen that the total of all costs using the least cost method results in a total of IDR. 11.540.000.

4.2. Stepping Stone Calculation

The stepping stone helps to find the optimum solution from the selected basic feasible solution. This tool can evaluate costs based on the transportation of goods through transportation routes not included in the solution [10].

This method calculates empty boxes by determining the loop path and calculating the value of the transportation costs [8]. Allocate as much as possible to boxes with negative loop values to lower transportation costs. The table is optimal if there are no negative values [11]. The results of the selected Initial Solution calculations are then processed using stepping-stone data.

Table 9. Stepping Stone Calculation

LC		DEMAND				Supply
		Bandung	Jakarta	Tangerang	Medan	
SUPPLY	Mojokerto	11000	12000	12000	15300	200
		120	80	TC2	TC3	
	Sidoarjo	12500	13000	13000	15000	700
		TC1	380	240	80	

Demand	120	460	240	80	900

Table 10. Stepping Stone Calculation

S2D1=TC1
S1D3=TC2
S1D4=TC3

Table 11. Stepping Stone Calculation

TC1=120(12500)+260(13000)+200(12000)+240(13000)+80(15000)=11.600.000
TC2=80(12000)+120(11000)+460(13000)+160(13000)+80(15000)=11.540.000
TC3=80(15300)+120(11000)+460(13000)+240(13000)=11.380.000

Because nothing is negative, the smallest cost is in the total cost calculation. The minimum solution with the Stepping Stone method is IDR. 11.380.000-. Thus the cost of distributing Xender Brand sandals from factories to warehouses to shops using the Stepping Stone method in December 2022 is Rp. IDR. 11.380.000.

5. Conclusion

The conclusions from this study are that it was obtained in Iteration 1 that the smallest cost was selected, namely 11,000 with a total demand of 120, then in Iteration 2, the smallest cost was selected 12,000 with a total remaining supply of 80. In Iteration 3, the smallest cost was selected, 13,000, with a total demand of 380. Iteration 4, the smallest cost of 13,000, is chosen with a total demand of 240. Moreover, Iteration 5's smallest cost is chosen, 15,000, with a total supply of 80. Total costs using the least cost method result in a total of IDR. 11.540.000. Meanwhile, the cost of distributing Xender Brand sandals from factories to warehouses to shops using the Stepping Stone method in December 2022 is Rp. IDR. 11.380.000.

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