International Journal of Transformation in Applied Mathematics & Statistics
Vol. 3, Issue 1 – 2020
ISSN: 2581-7620

Modelling Transportation Problem Using Harmonic Mean

Stephen I. Okeke[1]

[1]Department of Mathematics/Statistics, Ignatius Ajuru University of Education, PMB 5047, Port Harcourt, Nigeria.

Abstract

In this paper, the transportation problem was studied using Harmonic Mean Approach. The research work reviewed the modelled distribution of 50cl Pepsi soft drink Company of Nigeria (Agadaga & Akpan, 2019). Data collected by the scientists were analyzed using Microsoft Excel Software 2007 Version. The shipping schedule minimized the total cost of the shipment directly from the source to the sink.

Keywords: Harmonic Mean, Transportation Problem, Pepsi Soft Drink, Minimum Cost, Benin Production Plant, Microsoft Excel Software 2007 Version.

Introduction

The transportation problem is the maximum imperative and thriving utility of linear programming (LP) studied inside the place of operations research. It has its roots as antique as technological know-how and society. In the latest times, new techniques had been developed to improve the additives of the present platform (Ghadle, Munot 2019) including North-West corner approach, Minimum value method, Vogel's approximation method and Fuzzy transportation problem. It is of the interest of the writer to provide some evaluate on dependable strategies utilized by other researchers for solving transportation problem and fuzzy transportation problem through designing some new algorithms. Transportation Problem is classified as Balanced and Unbalanced transportation problem. A transportation hassle is said to be balanced if total supply from all resources is identical to the mixture demand of all locations. Otherwise, it is known as unbalanced transportation problem. If supply from sources is higher than demand, then we add a dummy column to make the problem balanced. If demand is better than supply, then we should add dummy row to transform given unbalanced problem to balanced problem. Though the origins of transportation hassle make bigger to even seventeenth century, when French Mathematician Monge formalized transportation issue in 1781, it was in 1941 whilst F. L. Hitchcock emphasized on 'Distribution of product from numerous sources to numerous localities, which the actual start, came about. Ghadle, Munot (2019) offered current advances on reliable methods for fixing transportation problem and fuzzy transportation problem through a survey table.

Transportation Model

Description of some reliable methods for solving the transportation problem

Anyone of the subsequent discussed strategies can obtain an Initial Basic Feasible Solution (IBFS) for a balanced transportation hassle.

A. North-West corner approach.

This approach starts off evolved on the north-west corner of the table. The most quantity is allocated to the cell at North-West corner then the amount of supply and demand is adjusted by subtracting allotted amount related to that cell. Cross out the row or column with no supply or demand remained to allocate. If each supply and demand internet to zero at a time, pass out anybody and go away 0 for uncrossed. Repeat this method till exactly one row or column is left uncrossed. In this approach, allocation doesn't work via considering transportation fee, so it may now not yield the proper initial answer every time.

B. Minimum value method

Name of this technique itself shows that it begins at a cellular which has the smallest unit value. Allocate the maximum quantity to the succession with the minor unit cost. If a tie happens, break it arbitrarily. Adjust the quantity of supply and demand related to that cell by means of subtracting the allotted quantity. Cross out the row or column and not using a supply or demand remained to allocate. If both supply and demand net to zero at a time, go out every person and depart 0 for uncrossed. Repeat this system till exactly one row or column left uncrossed. This method gives better solution than North-West corner technique.

C. Vogel's approximation technique

In this approach, we compute the difference of smallest entries in every row and every column of the table and write this difference contrary to row or column. Then pick out the most significant difference and use the smallest value in corresponding row or column to empty a warehouse or fill market demand. If a tie takes place, smash it arbitrarily. Circle the fee used and allocate the most amount to that cell adjust the quantity of supply and demand related to that cell by subtracting the allocated amount. Cross out the row or column without a supply or demand ultimate to allot. If each supply and demand net to zero simultaneously delete the row except that row is the simplest row last in which case eliminate the column. Repeat the procedure till all table entries deleted. This approach gives a better solution than the above two techniques, however it calls for a lot time to compute the answer.

International Journal of Transformation in Applied Mathematics & Statistics
Vol. 3, Issue 1 – 2020
ISSN: 2581-7620

Algorithm for the Harmonic Mean Method

Harmonic mean is the reciprocal of the arithmetic mean of reciprocals. It can be used to calculate a mean that reduces the impact of outliners. The following steps showed the harmonic mean algorithm to be taken when solving transportation problems:

Step I: The given Transportation Problem should be represented in the form of cost matrix.

Step II: Check if the total supply equals total demanded; if not the given Transportation Problem is not balanced. To balance the Transportation Problem, add dummy to either to the row or column.

Step III: Find the harmonic mean of each row and each column of the given Transportation Problem.

Step IV: The row or column which has the highest harmonic mean is selected.

Step V: Make maximum possible allocation to the cell that has minimum cost in Step (IV).

Step VI: The row or column which satisfied the demand or supply is crossed.

Step VII: Repeat Steps (IV-VI) until the whole demand and supply are satisfied.

Step VIII: Add the multiplication of all allocations and corresponding cost to get the transportation cost.

Data Presentation And Analysis

Table 1 Transportation cost per create of Pepsi (50cl) per week from the source to the destinations and the respective demand and quantities supplied (Agadaga & Akpan, 2019) (end of the paper)

Following Step (II): $\sum b_j = 10{,}000$ and $\sum a_i = 110{,}000$.

Thus, $\sum b_j < \sum a_i \Rightarrow \sum b_j + \sum d_j = \sum a_i$, where $\sum d_j = 100{,}000$ is called the dummy according to requirement of supply/demand.

Table 2 A Table showing the balanced Transportation Problem (end of the paper)

The table 2 corresponds to results of Agadaga and Akpan, 2019 as referenced.

Following the Step III to the Step VII to generate the table below: In table 3, with the harmonic means on Row and 11.031 on row 1 is bigger than any other definite value on column)

Table 3 A table showing the Harmonic Mean (end of the paper)

Next, following the last step which is step VIII by adding the multiplication of all allocations and corresponding cost to get the transportation cost:

N 9.11 (740) +N 9.73 (820) +N 9.30 (920) + N 9.11 (730) +N 9.11 (730) + N 9.00 (1200) + N 11.01 (1300) + N 11.23 (1200)+ N 12.40 (820) + N 12.98 (820) + N10.24 (720) = N 6741.4 + N 7978.6 + N 8556 + N 6650.3 + N 6650.3 + N 10800 + N 14313 + N 13476 + N 10168 + N 1063.6 + N 7372.8 = N 103350.00.

Discussion and Conclusion

The Harmonic Mean Method is effective which has been used by following the steps mentioned above. The table 4 gave the minimum cost that the company can transport the 10,000 creates of 50 cl Pepsi to their esteemed customers within the major cities from the source (Benin transport plant).

Table 4.A table showing the optimum cost for transshipping 50 cl Pepsi

Source	Sink	Price (P)	Quantity (Q)	PQ (N)
Benin	Jesse	9.11	740	6741.4
Benin	Koko	9.73	820	7978.6
Benin	Oghara	9.30	920	8556
Benin	Mosogar	9.11	730	6650.3
Benin	Gara	9.11	730	6650.3
Benin	Amukpe	9.00	1200	10800
Benin	Jakpan	11.01	1300	14313
Benin	Effurun	11.23	1200	13476
Benin	Osubi	12.40	820	10168
Benin	Igbudu	12.98	820	10643.6
Benin	Adeje	10.24	720	7372.8
			Total Cost	N 103350.00

References

1. Agadaga, G.O. and Akpan, N.P. (2019). A Transshipment Model of Seven-Up Bottling Company, Benin Plant, Nigeria. *American Journal of Operations Research*, 9, 129-145.
2. Kirtiwant P. Ghadle, Dhanashri A. Munot (2019). Recent Advances on Reliable Methods for Solving Transportation Problem and Fuzzy Transportation Problem. *Systematic Review Article*, 26 (2):95-107.

International Journal of Transformation in Applied Mathematics & Statistics
Vol. 3, Issue 1 – 2020
ISSN: 2581-7620

Table 1.Transportation cost per create of Pepsi (50cl) per week from the source to the destinations and the respective demand and quantities supplied (Agadaga & Akpan, 2019)

From:	12	13	14	15	16	17	18	19	20	21	22	
	Jesse	Koko	Oghara	Mosogar	Gana	Amukpe	Jakpan	Effurun	Osubi	Igbudu	Adeje	Supply
1. Benin (B)	9.11	9.73	9.30	9.11	9.11	9.00	11.01	11.23	12.40	12.98	10.24	**10000**
2. Swift (S)	1.40	8.65	2.20	1.40	1.40	1.73	9.75	9.25	10.05	9.05	7.67	**10000**
3. Frendo (Fr)	1.55	9.65	3.35	1.55	1.55	0.69	9.77	9.45	10.15	9.15	7.73	**10000**
4. Clement Vents (Cl.V)	2.35	9.45	2.85	2.35	2.35	7.35	9.65	9.55	9.85	8.85	8.35	**10000**
5. Life Dew (L.D)	8.11	9.99	8.61	8.11	8.11	7.81	7.21	6.71	7.51	7.40	7.11	**10000**
6. Osoro (Os)	8.39	10.02	8.89	8.39	8.39	8.19	7.49	6.01	7.79	7.68	7.39	**10000**
7 . Afoke (Af)	8.60	10.23	9.10	8.60	8.60	8.40	7.70	7.50	8.00	7.71	7.60	**10000**
8. Oriemu Vents (Or. V)	9.44	10.82	9.94	9.44	9.44	9.24	8.54	8.04	8.84	8.54	8.64	**10000**
9. T & O	8.45	10.10	8.95	8.45	8.45	8.25	7.55	7.05	7.85	7.25	8.45	**10000**
10. Best Beer (B.B)	9.13	10.38	9.63	9.31	9.13	8.93	7.13	6.63	7.33	7.03	9.13	**10000**
11. Stella Chukwu (S.C)	9.31	10.65	9.81	9.31	9.31	9.21	7.41	6.09	7.71	7.31	9.31	**10000**
Demand	**740**	**820**	**920**	**730**	**730**	**1200**	**1300**	**1200**	**820**	**820**	**720**	

International Journal of Transformation in Applied Mathematics & Statistics
Vol. 3, Issue 1 – 2020
ISSN: 2581-7620

Table 2 A Table showing the balanced Transportation Problem

					To:																	
From:																						
	12. Jesse	13. Koko	14. Oghara	15. Maragar	16. Gana	17. Amukpe	18. Jakpan	19. Effurun	20. Osubi	21. Igbudu	22. Adeje	23 Swift	24 Frendo	25. Clement Vents	26 Life Dew	27 Osoro	28 Afoke	29 Oriemu Vents	30 T & O	31 Best Beer	32 Stella	Supply
1. Benin	9.11	9.73	9.30	9.11	9.11	9.00	11.01	11.23	12.40	12.98	10.24	9.60	9.90	10.20	13.10	13.70	13.88	13.92	13.20	13.83	13.65	10000
2. Swift	1.40	8.65	2.20	1.40	1.40	1.73	9.75	9.25	10.05	9.05	7.67	0.00	0.60	1.00	7.41	9.65	10.10	10.50	7.51	9.95	10.10	10000
3. Frendo	1.55	9.65	3.35	1.55	1.55	0.69	9.77	9.45	10.15	9.15	7.73	0.60	0.00	0.98	8.20	8.40	9.85	10.60	8.30	8.70	10.20	10000
4. Clement Vents	2.35	9.45	2.85	2.35	2.35	7.35	9.65	9.55	9.85	8.85	8.35	1.00	0.98	0.00	9.80	10.00	11.20	11.90	9.90	10.30	11.50	10000
5. Life Dew	8.11	9.99	8.61	8.11	8.11	7.81	7.21	6.71	7.51	7.40	7.11	1.40	1.60	0.80	0.00	0.70	1.00	1.50	0.10	1.10	1.10	10000
6. Osoro	8.39	10.02	8.89	8.39	8.39	8.19	7.49	6.01	7.79	7.68	7.39	9.65	8.40	10.00	0.70	0.00	0.80	0.50	0.40	1.00	0.90	10000
7 . Afoke	8.60	10.23	9.10	8.60	8.60	8.40	7.70	7.50	8.00	7.71	7.60	10.10	9.85	11.20	1.00	0.80	0.00	0.40	1.20	1.20	0.80	10000
8. Oriemu Vents	9.44	10.82	9.94	9.44	9.44	9.24	8.54	8.04	8.84	8.54	8.64	10.50	10.60	11.90	1.50	0.50	0.40	0.00	1.30	0.70	0.50	10000
9. T & O	8.45	10.10	8.95	8.45	8.45	8.25	7.55	7.05	7.85	7.25	8.45	7.51	8.30	8.30	0.10	0.40	1.20	1.30	0.00	0.50	1.00	10000
10. Best Beer	9.13	10.38	9.63	9.31	9.13	8.93	7.13	6.63	7.33	7.03	9.13	9.95	8.70	10.30	1.10	1.00	1.20	0.70	0.50	0.00	1.00	10000
11. Stella Chukwu	9.31	10.65	9.81	9.31	9.31	9.21	7.41	6.09	7.71	7.31	9.31	10.10	10.20	11.50	1.10	0.90	0.80	0.50	1.00	1.00	0.00	10000
Demand	740	820	920	730	730	1200	1300	1200	820	820	720	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	

Table 3.A table showing the Harmonic Mean

	Harmonic mean on Row	Assigned associated supply			Harmonic mean on Column		Assigned associated demand
Row 1	11.031			Column 1	4.082030471		
Row 2	#NUM!	10000		Column 2	9.935435133		
Row 3	#NUM!	10000		Column 3	5.589171077		
Row 4	#NUM!	10000		Column 4	4.085240827		
Row 5	#NUM!	10000		Column 5	4.082030471		
Row 6	#NUM!	10000		Column 6	3.555657571		
Row 7	#NUM!	10000		Column 7	8.094711392		
Row 8	#NUM!	10000		Column 8	7.651127037		
Row 9	#NUM!	10000		Column 9	8.638588342		
Row 10	#NUM!	10000		Column 10	8.21544523		
Row 11	#NUM!	10000		Column 11	8.23520217		
				Column 12	#NUM!		10000
				Column 13	#NUM!		10000
				Column 14	#NUM!		10000
				Column 15	#NUM!		10000
				Column 16	#NUM!		10000
				Column 17	#NUM!		10000
				Column 18	#NUM!		10000
				Column 19	#NUM!		10000
				Column 20	#NUM!		10000
				Column 21	#NUM!		10000

#NUM! takes the position of a cell with highest harmonic mean.