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TOTAL COST MINIMIZATION TRANSPORTATION PROBLEM

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Abstract

Optimization models can be used to determine the lowest cost solution to ship products from the manufacturing origin to the end customer. This Caps tone developed a mixed integer linear programming model for Carlstar, a global leader in the specialty tire and wheel industry. The objective was to identify the optimal routing solution of problem to minimize total cost transportation and tariff costs for each of the company's five product market segments. The model provided for multiple possible routing options, including shipping direct to the customer from the manufacturer or through a distribution center. Multiple scenarios were run using different rates for transportation costs, tariffs, and customer demand. Model constraints included manufacturing location, demand, and flow balance through the distribution centers. Results indicate that Carlstar could save almost 20% on distribution costs by increasing the number of direct to customer shipments. The impacts of tariffs, demand fluctuations and handling costs were smaller than expected, indicating that once an updated transportation network is established, it would not have to be updated very often to maximize potential cost savings.

KEYWORD: Total cost, minimization, transportation, problems, solution

INTRODUCTION

Today's supply chains have become "a challenge as production and supply networks have expanded and serve an increasingly demanding series of customers in multiple markets. Coordinating the flow of product material and the flow of information across all levels of the supply chain is essential for effective management of these supply chain networks [1, 2]. Therefore, the extent to which manufacturing products can affect society depends on the efficiency of sector management in its supply chain and logistics services. The timely movement of the materials needed for production requires the development of a good distribution network. In previous studies it was concluded that although a good distribution network minimizes costs and maximizes profits in shipping finished products to customers and consumers [3, 4], poor distribution caused by an inefficient transportation system can disrupt the supply chain, leading to an unavailability of raw materials or finished products and, ultimately, affect the economy both nationally and individually [5]. This is probably due to the fact that a good transport system ensures high availability and low cost of transport services compared to the cost of inventory, thus encouraging fast and frequent deliveries through [6]." These keys argue that "an efficient transportation system (an aspect of logistics) is essential for economic development and growth [7], while achieving and sustaining development is

Methodology

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At a public limited firm with supply and storage facilities spread out across the state, a case study-based approach was used. The study's main objective was to identify the company's present transportation model because it does not apply any optimization techniques. recalculating the transportation cost with both the original VAM methods and the new Vogel Approximation methods.

Objectives

To assess the efficacy of the planned modified VAM to VAM in terms of cost expressed to the firm.

Limitations

- The study was assumed in a short time period and could not be comprehensive in entire respects. The study was undertaken in a short time period and could not be comprehensive in every respect.
- The improved method does not assure that it will outperform the previous approaches for all unbalanced transportation issues. According to the findings, the suggested strategy offers the best initial solution for every ten transportation issues in just seven of them.
- As a result, transportation costs vary across the state.

Literature review

Blumenfeld et al. conducted a study that identified optimal delivery strategies for goods on a freight transport network. They analyzed the relationship between transportation, storage, and production set-up costs in order to minimize total costs. A decomposition method was presented to solve problems with few origins and shipping dimensions.

- A similar study has been published by Burns et al. [10], which explored the problem of reducing total inventory and freight costs from each supplier to more customers using the economic order quantity model (EOQ) structure.
- Zhao et al. “addressed the problem of determining the optimal order quantity and frequency for a supplier-dealer logistics system in which transport costs and multiple uses of vehicles are considered.
- Based on the traditional formula of the quantity of the economic orders, a modified EOQ model is set up and an algorithm for the model is presented. The purpose of the model is to reduce production, inventory and transportation costs.”
- Sugato Bagchi et al. talks about the Supply chain simulator, which can help a company to make a strategic business decision about the design and operation of its supply chain, what makes SCS different from traditional types of discrete event simulations. We can reduce transportation cost by using SCS which is the best of using SCS.

Analysis and Discussions

Poor logistics planning and judgment can lead to extra costs, missing delivery dates, and a loss of goodwill for the company. As a result, boosting functional inefficiency and decreasing supplying costs should be among the topmost goals for any organization that relies on the physical delivery of products if it is to stay financially viable.

Summary of Demand During 2019-20

Table 1 states the demand for any products at various destinations in 2019-20. Minimal demand was observed at O1 while Maximum demand was reported at D9.

Table 1: Summary of Demand During 2019-20

District	Demand (Tonne)
O1	441
O2	1327
O3	1315
O4	2840
O5	4415
O6	3784
O7	5235
O8	5444
O9	5770
O10	2385
O11	4250
O12	2576
O13	520
O14	3398
Total	43700

Source: Secondary Data

Summary of Supply During 2019-20

The Rajasthan state food corporation is stored in four warehouses from where it is distributed to 14 major districts of Rajasthan because the manufacturing company lacks any production facilities in the state of Rajasthan. The storage capacity of the various warehouses is shown in Table 2. It is evident that warehouse 2 (W2) has the most capacity while warehouse 1 has the lowest (W1).

Table 2: Summary of Supply During 2019-20 Source: Secondary Data

Warehouse	Material in stock (Tonn)
W1	5000
W2	18000
W3	15000
W4	5700
Total	43700

Assumptions for Calculating the Transportation Cost

- Some presumptions were established in that order, to work on the transportation hypothesis.
- It was necessary to know the separations between the warehouses and the locations. The distance between the warehouse and the destination was given as an estimate.
- For Calculating the cost of transportation, a single truck load was considered to be at least 10 tonnes in order to estimate the cost of transportation. It is expected that one cargo will cost Rs. 80 per km to carry (referring to the company regulation). Hence, it was calculated that it would cost Rs. 8 to carry 1 tonne per km.

Table 3: Estimate of Unit Transportation Cost

Source/ Destination	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13	O14	Supply
W1	1550	1246	990	486	534	198	670	1166	1278	1598	2246	2262	3062	870	50000
W2	950	606	510	366	142	542	1038	1518	1774	1886	2278	2718	3502	822	18000
W3	2974	2518	2318	1814	1838	1382	958	1054	606	182	686	766	1478	2198	15000
W4	2214	1718	1558	1078	1038	614	94	502	406	998	1430	1662	2430	1198	5700
Demand	441	1327	1315	2840	4415	3784	5235	5444	5770	2385	4250	2576	520	3398	43700

Source: Analysis

Transporting food production from various origins to various destination locations will cost you per unit as shown in Table 3. The unit cost will vary due to the variance in travel distances between each warehouse and the various demand locations. In this case, it is expected that one tonne of potash will cost Rs. 8. Now, one may calculate the cost of unit transportation by multiplying the distance between the point of origin and the destination by the rate for shipping one tonne of potash per kilometer. The cost of moving one tonne per km divided by the distance from the origin to the supply destination is the unit transportation cost.

Analysis of the Active Transportation Cost matrix

Table 4: Active Transportation Cost

Source/ Destination	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13	O14	Supply
W1	876	728	787	583	578	569	556	619	765	888	1107	1093	1225	865	10000
	120	440	245	500	380	3510	105	210	825	50	970	1330	270	215	
W 2	801	752	563	488	354	638	0	0	0	0	0	0	0	886	15200
	321	887	1070	2340	4035	274								3183	
W3	0	0	0	0	0	0	0	606	572	422	684	613	650	0	15600
								35	4945	2335	3280	1246	250		
W4	0	0	0	0	0	0	331	550	0	0	0	0	0	0	11900
							5130	5200							
Demand	441	1327	1315	2840	4415	3784	5235	5444	5770	2385	4250	2576	520	3398	43700

Source: Analysis

Multiplying the unit transportation value from each origin to the supply destination with the supply of food products available at that location yields the overall cost for moving food products from different warehouse to required destinations.

One of the company's demand destinations is District 1 (O1), and Table 4 shows that the unit transportation cost for moving products there is Rs. 876. A further 120 tonnes of food product are being delivered to O1 by the business from Warehouse 1. This results in an overall expense of Rs. 1,05,120 (876 * 120) for the transportation of products from W1 to O1.

Optimized Transportation system Model Using Vogel's Approximation Method & Modified VAM

There are, two optimization techniques— Vogel's approximation method and Vogel's Modified approximation method—are used for analysis in comparison.

Optimizing Transportation Cost by using VAM

The primary basic answer for the company's current requirement scenario is shown in Table 5 utilizing Vogel's approximation approach. This results in a total transportation expense of Rs. 2,14,59,876 when utilizing VAM. In comparison to the company's present transportation strategy, this optimized model implies that it is significantly superior.

Table 5: Optimised Transportation Cost using VAM

Source/ Destination	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13	O14	Dummy	Supply
Warehouse 1	1552	1248	992	488	536	200	672	1168	1280	1600	2248	2264	3064	872	0	10000
							4519							3388	2093	
Warehouse 2	952	608	512	368	144	544	1040	1520	1776	1888	2280	2720	3504	824	0	15200
	510	1317	1305	2830	4405	3794									1039	
Warehouse 3	2976	2520	2320	1816	1840	1384	960	1056	608	184	688	768	1480	2200	0	15600
										2395	4240	2566	436		5963	
Warehouse 4	2216	1720	1560	1080	1040	616	96	504	408	1000	1432	1664	2432	1200	0	11900
							706	5434	5760							
Demand	510	1317	1305	2830	4405	3794	5225	5434	5760	2395	4240	2566	436	3388	9095	52700

Source: Analysis

Table 6: Optimising Transportation Cost Using MVAM

Source/ Destination	O1	O2	O3	O4	O5	O6	O7	O8	O9	O10	O11	O12	O13	O14	Dummy	Supply
Warehouse 1	1552	1248	992	488	536	200	672	1168	1280	1600	2248	2264	3064	872	0	10000
						3794								1687	4519	
Warehouse 2	952	608	512	368	144	544	1040	1520	1776	1888	2280	2720	3504	824	0	15200
	510	1317	1305	2830	4405									1701	3132	
Warehouse 3	2976	2520	2320	1816	1840	1384	960	1056	608	184	688	768	1480	2200	0	15600
									4519	2395	4240	2566	436		1444	
Warehouse 4	2216	1720	1560	1080	1040	616	96	504	408	1000	1432	1664	2432	1200	0	11900

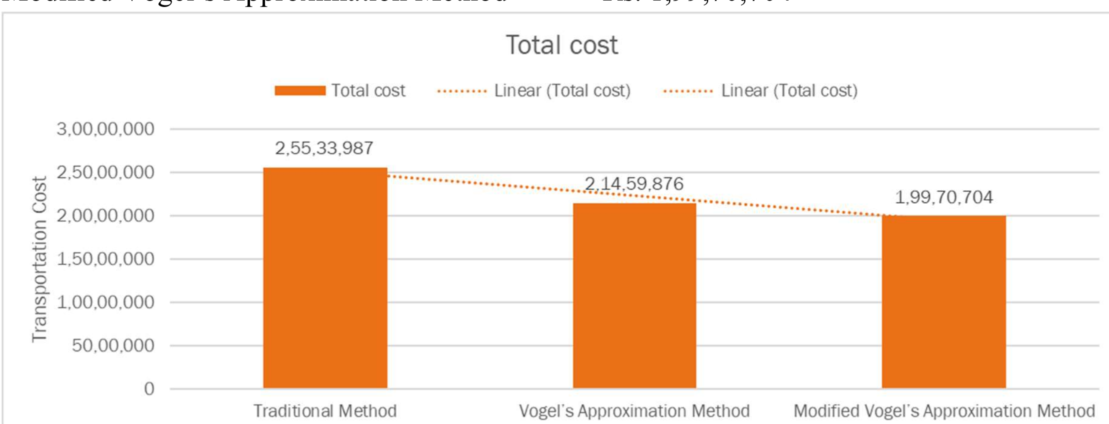
							5225	5434	1241							
Demand	510	1317	1305	2830	4405	3794	5225	5434	5760	2395	4240	2566	436	3388	9095	52700

Table 6 represents the initial basic solution for the current situation of the company by using Modified Vogel's approximation method. Using modified Vogel's approximation method, the total transportation cost was calculated to be Rs 1,99,70,704.

Comparison of the Transportation Models

By comparing the transportation costs calculated using Vogel's approximation, the firm's traditional technique, and lastly a modified Vogel's approximation method. Using the conventional technique resulted in transportation costs of Rs. 2,55,33,987, Rs. 2,14,59,876 and Rs. 1,99,70,704 using VAM and MVAM, respectively. This demonstrates that compared to the other two ways, the modified Vogels method offers superior cost reductions. The company may save as much as Rs. 55,63,283 by utilising the modified Vogel's approximation approach. Compared to VAM, MVAM is more effective. There will be a long-term beneficial impact on the company's profitably.

Method	**Total Cost**
Traditional Method	Rs. 2,55,33,987
Vogel's Approximation Method	Rs. 2,14,59,876
Modified Vogel's Approximation Method	Rs. 1,99,70,704



Conclusion

Uncertainty over demand can have an impact on transportation costs. If there is little demand, transportation costs will be low; yet, as was already demonstrated, if there is substantial market demand for a product, transportation costs will be high. Certain techniques are used to lower the cost of transportation and find a workable solution in order to optimize this cost. Since the company didn't follow any specific coordinated transportation strategy, its transportation costs were increasing. However, this case study showed that transportation expenses could be reduced by as much as Rs. 55,63,283. According to the case study, the MVAM strategy generated a profit that was Rs. 1,489,172 greater than the VAM strategy. This led to the conclusion that the modified Vogel's approximation approach was far more effective than Vogel's approximation technique. From the graph, it can be observed that the difference in transportation cost by VAM and MVAM is 7.18%.

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