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Model Employing the VAM-MODI Method for Risk Management in the Transportation of Commodities

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ABSTRACT

One of the key concerns for every industry in regards to delivering items to their intended recipients safely and on schedule is transport risk management. Both damaged items and late shipments cost the company money and impair the company's reputation. All approach for transportation needs to be comfortable in order to guarantee that the commodities will arrive without harming the items, on schedule, and cost effectively. In this article, we uncover a few common dangers that could affect all kinds of routes, such as highways, waterways, airports, railways, and so on. Further, we suggested a method for solving a transportation problem utilizing VAM-MODI method (Vogel's Approximation Method-Modified Distribution). Lastly, utilizing a multi-optimality approach to the transportation problem, we lower the hazards by reducing the potential number of transportation routes .

Keywords: VAM, MODI, transportation problem.

INTRODUCTION

An effective transportation system is crucial for the nation's long-term economic growth and is a key factor in advancing regional and international integration. An effective transport network stimulates the economy and boosts the economy's viability. Rapid expansion requires a reliable transportation system. The movement of goods and services from the source of supply to the point of demand does not happen automatically. It takes transportation to get these products and services from the point of supply to the point of need.

The three most crucial supply-chain requirements that must be met by a conventional transportation system are that the goods be delivered on time, in great condition, and at a fair price. This idea can be transformed into a series of feasible tasks, and their effective completion will ensure the fast and effective distribution of humanitarian supplies. When doing so, moving goods from a factory or other source to recipients must be done safely. Moving things through the various routes of transportation involves a lot of issues.

A. Risk Management System in Transportation Sector

Safeguarding goods from potential threats while transferring them from sources to destinations is the key concern in the transportation sector . The recipient's anticipated delivery time should also be

considered when acquiring the subsequent work order. A risk management system is defined in this essay as a procedure or a system that reduces the risks involved in the scheduled and secure transportation of products.

B. Systemic Risks in the Transportation Industry

Risk factors are common perils that could obstruct the supply chain by slowing down the delivery or resulting in damage to the goods or its component parts during any mode of transportation. Some of these typical risks are listed below:

1.Traffi c

Traffic is thought to be the biggest problem with the logistics system since it makes it more likely that a distributor either miss a cargo or an airlines or encounter setbacks in the supply of their goods. In addition, it will lead to the revocation of the work packages, which will end up causing a business to lose those particular clients. Consequently, it is frequently advised to avoid congested routes when delivering goods from sources to destinations.

2. Wildlife and Natural Catastrophes

Some problems, such as those caused by natural blunders and those brought on by the use of livestock, are outside the human realm of understanding and are uncontrollable. For contrast, when there is intense rain, flooding, or a landslide, this could actually result in a number of unanticipated issues. Even animals create a lot of problems on freeways by forming groups, blocking the roads, and standing there.

3. Accident

Accidents are the next worst-case scenario and unforeseen difficulties when transporting any precious or professional products. Both the service providers and the people who utilize the facilities suffer damages in an accident. The lives of the drivers themselves could be lost, the items being transported could be damaged, and several other issues.

MATERIALS & METHODS

A minimal cost solution to the transportation issue is offered by the modified distribution technique, sometimes referred to as the MODI method or (u v) method:

Step 1: Construction of the transportation table is done by inputting the origin capacity ai, the destination requirements bj, and the cost cij.

Step 2: Using any of the transportation algorithms arrive at an initial basic solution. This paper uses the VAM method as it has been proven to give the best initial solution.

Step 3: Solve the system of equations ui + vj = cij for all the basic variables xij; beginning with the initial values of ui = 0, determine the values of ui and vj on the transportation table for all i, j for which cell (i, j) is in the basis.

Step 4: Calculate the cost differences for each non-basic cell using the formula dij = (ui + vj - cij).

Step 5: Look for each opportunity cost's indicator. The suggested solution is the best one if all of the empty (unallocated) cells have opportunity costs that are either positive or zero. However, if one or more vacant cells have negative opportunity costs, the provided option is not the best one and additional transportation cost savings are available.

Step 6: Choose the vacant cell to be a part of the following solution that has the least negative opportunity cost.

Step 7: Draw a closed path or loop around the vacant cell that was chosen in the previous step, making sure that each of its corners is filled with occupied (assigned) cells. It is to be noted that only occupied cells and the initial vacant cell are allowed for the right angle turn in this path.

Step 8: A positive sign should be placed in the cell that is being assessed, and alternate positive

and negative signs should be placed at the vacant cells on the corner points of the closed route.

Step 9: The maximum number of units which should be sent to the empty cell is determined. The number of units that can be transported to the entering cell is represented by the smallest value with a negative location on the closed path. Now it is removed from all of the cells on the closed path's corner points indicated with negative sign and it is added to all of the cells on the corner points marked with positive signs. In this manner, an empty cell is transformed into an occupied cell.

Step 10: Repeat the entire process until the optimal solution is found.

The above 10 steps of transportation algorithm are implemented using python code

The code was executed and used for computing the values for two different cost matrices. The matrix containing the costs, supply, and demand of the two is as shown in table 1 and table 2.

TABLE.1: COST MATRIX WITH SUPPLY AND DEMAND

	A	B	C	D	SUPPLY
A	8	6	12	9	400
B	7	11	10	14	500
C	13	8	8	7	600
DEMAND	325	425	475	275	

TABLE.2: COST MATRIX WITH SUPPLY AND DEMAND

	A	B	C	D	SUPPLY
A	19	30	50	10	7
B	70	30	40	60	9
C	40	8	70	20	18
DEMAND	5	8	7	14	

The solution to the above was found using traditional hand calculation method and the answer was found to be as shown in Table.3.

TABLE.3: BASIC AND OPTIMAL SOLUTIONS

	BASIC SOLUTION	OPTIMAL SOLUTION
COST OF FIRST MATRIX	1095	1095
COST OF SECOND MATRIX	779	743

RESULT

The same algorithm is executed into python code in PyCharm software. The important feature of using this in python is it significantly reduces computation time, reduces risks and secures transportation in a time critical system. The output showing the optimal solution and assignments for the two cost matrices in question is shown in Fig.1. and the execution time to get the optimal solution is **131.328ms** which is extremely handy in real time solutions.

```
Basic feasible solution:
Cost:  10950
Assignment:
 [[325, 7, (1, 0)], [400, 6, (0, 1)], [275, 7, (2, 3)], [
25, 8, (2, 1)], [300, 8, (2, 2)], [175, 10, (1, 2)]]

Optimal solution:
Cost:  10950
Assignment:
 [[325, 7, (1, 0)], [400, 6, (0, 1)], [275, 7, (2, 3)], [
25, 8, (2, 1)], [300, 8, (2, 2)], [175, 10, (1, 2)]]

-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x
-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x
-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x-x
-x-x-x

Basic feasible solution:
Cost:  779
Assignment:
 [[8, 8, (2, 1)], [5, 19, (0, 0)], [10, 20, (2, 3)], [2,
10, (0, 3)], [7, 40, (1, 2)], [2, 60, (1, 3)]]

Optimal solution:
Cost:  743
Assignment:
 [[6, 8, (2, 1)], [5, 19, (0, 0)], [12, 20, (2, 3)], [2,
10, (0, 3)], [7, 40, (1, 2)], [2, 30, (1, 1)]]
```

FIG.1. Extract From Pycharm Output Window

CONCLUSION

The commodities must be delivered on schedule, in excellent shape, and at a reasonable cost, which are the three most important supply-chain requirements that a traditional transportation system must fulfil. Risk factors are frequent dangers that could hinder the supply chain by delaying delivery or causing damage to the items or its component parts while being transported by any means. The MODI technique has been used frequently to address hazards and assign the best solutions. With the development of technology, the pace of transportation has accelerated, necessitating the completion of the optimal allocations at a comparable rate. As a result, programming the algorithm in Python has been extremely successful in attaining this goal.

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Conflict of Interest: None

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