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Transformation of the transport system with reference to Navi-Mumbai

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***Abstract*—**
India, one of the economies with the fastest growth rates in the world, is expanding at a rate of 7% annually. The nation is striving hard to alter itself over the next few decades, with a population that is also expanding. The Indian government has public transit improvement high on its priority list. Even though private vehicle ownership in India is rising and producing significant traffic issues in big areas like Navi-Mumbai, there are numerous initiatives to upgrade and modernize transport systems. At least 1.42 billion people, or around 35.87% of the population of the country, are estimated to live in urban areas, according to the World Bank's collection of Development Indicators 2022. Even while the amount of urbanization may appear to be low in percentage terms, there are a huge number of people living in cities. India's urban population currently outnumbers the populations of Brazil and the United States combined. India's level of urbanization is predicted to rise even more, and by 2030, there should be around 600 million people living in cities. Sadly, there is a rising quantity of traffic on the streets of our cities nowadays, which is increasing the time it takes for goods to be transported as well. This traffic is also a big factor in problems like air and noise pollution, traffic accidents, and serious health hazards for locals. Technology will be crucial in identifying mobility gaps and altering current transport systems in order to create an inclusive, safer, and more sustainable city of the future. we are solving the transportation problem with the help of dual simplex and two-phase methods. Here we are solving this problem with the help of the Branch and Bound Method of Integer Programming Problem by using R software and we are comparing the obtained optimal solution with the Vogel Approximation Method.

***Keywords*—** Congestion, collision, Pollution, Transportation, Urbanization, R, VAM

I. Introduction:

Navi Mumbai is also known as the twin city of Mumbai. This city was designed by renowned urban planner and architect Charles Correa, structural engineer Pravina Mehta, and engineer Shirish Patel. It is situated in the western suburbs of Mumbai. A freshly constructed township called Navi Mumbai is a well-planned metropolis with a robust infrastructure for its time.

In early 1964, Navi Mumbai was designed as a diversion from the unending traffic congestion in Mumbai and the city's rapidly expanding population. A 343.70 square km area from Thane to Raigad was included in the development plan for Navi Mumbai created by CIDCO. In addition, the idea received official approval from the Maharashtra government in August 1979. The site was chosen because it would be simpler to relocate the population because it was across the harbour from Bombay Island. Making livable spaces and a mass transit system was crucial.

The following were the primary drivers of the relocation:

1. Bombay's deterioration of older buildings
2. Better and more affordable housing amenities in Navi Mumbai.
3. More employment opportunities are available in Navi Mumbai.
4. Shorter distances for commuting

One cannot dispute the fact that most of Navi-Mumbai's population relies on public services when discussing the transportation infrastructure of a large and well-known city in India like Navi-Mumbai. However, given the current traffic jams on the roads, the time it takes for products to be transported is now also a problem. Apart from a few sections during the morning and evening rush hours, Navi Mumbai is a planned city and does not experience significant traffic congestion in some areas. Additionally, the Sion-Panvel Highway experiences heavy traffic during any hour of the day as a result of the significant increase in vehicle traffic.

India's Navi-Mumbai has traditionally had a strong transit infrastructure. In order to fulfill the rising demand for transport services, both rail and buses have greatly expanded but still for goods transport is by road only. Although the present administration is working to meet the minimum requirements for public transportation as well as for trucks, tempos and other means of goods transport but land restrictions are the main problem impeding further development programs and concepts in this particular sector. Cause of transport system:

The main causes of traffic bottlenecks in Navi Mumbai are several. Among the most frequent causes are:

1. Heavy traffic on main thoroughfares and highways as a result of dense population and rising vehicle ownership.
2. Insufficient infrastructure for alternate means of transportation and a lack of public transit choices.
3. Roadwork and construction that causes lane closures and detours.
4. Ineffective local government agency coordination and traffic management.
5. Inadequate land use planning and unplanned urban growth.

It is crucial to remember that several additional factors, such as weather conditions, accidents, and special events, can also contribute to traffic bottlenecks. The time of day and day of the week can also affect traffic patterns and congestion levels.

II. Objective:

The main objective is to minimize expenses and maximize profit. The starting site is where transportation issues originate, and the destination is where they are conveyed to move the goods at the lowest possible cost without compromising supply and demand.

III. Literature Review cost minimizing transportation problem:

A better VAM approach was put out by Korukoglu and Balli (2011) for the transportation issue. Phase-II of the simplex technique was employed by Sharma et al. (2011) to address the transportation issue. solving the transportation issue using the integer programming problem that Gaurav Sharma et al. (2012) described. Sudhakar et al. (2012) suggested a novel method for identifying the best solution to the transportation challenge. For TP of Three Variables, Rekha (2013) suggested optimisation approaches. An algorithm was created by Mollah Mesbahuddin Ahmed et al. (2014) to identify an initial basic workable solution for both the balanced and unbalanced TP.Rekha et al. developed a max min penalty solution to the transportation cost minimization problem in 2014.A solution to the transport problem's degeneracy was put out by Sarbjit Singh in 2015.

To calculate the shortest travel time, Sharif Uddin (2012) used a transportation algorithm. The time-minimizing TP with fractional bottleneck objective function was discussed by Jain and Saksena in 2012. Pavel Kolman (2015) put forth a fresh approach to cut down on the amount of time required to move materials from collection points to processing facilities.

For the purpose of solving a MOTP with fuzzy coefficients, Surapati and Roy (2008) investigated a fuzzy goal programming approach based on priorities. Fuzzy logic-guided non-dominated sorting genetic algorithm was used by Lau et al. (2009) to resolve the MOTP, which is concerned with the optimisation of vehicle routing when numerous items, multiple consumers, and different depots are considered. To identify the ideal compromise solution of a problem, Lohgaonkar and Bajaj (2010) used the fuzzy programming technique with linear and non-linear membership functions. The time-minimizing TP with fractional bottleneck objective function was discussed by Jain and Saksena in 2012. Pavel Kolman (2015) put forth a fresh approach to cut down on the amount of time required to move materials from collection points to processing facilities.

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IV. Formulation Transportation problem:

Given p origins and q destinations, the transportation problem can be formulated as the following linear programming problem model:

Minimize: $$\sum_{r=1}^{p}\sum_{k=1}^{q} crkxrk$$

Subject to constraint:

$$\sum_{k=1}^{q} xrk \leq ar \qquad r= 1, 2,\ldots, p$$

$$\sum_{r=1}^{p} xrk \leq bk \qquad k= 1,2,\ldots,q$$

$xrk \geq 0$ for all r and k

Where xij is the number of units shipped from origin r to destination k and crk is the cost of shipping one unit from origin r to destination k. The amount of supply at origin r is ar and the amount of destination k is bk. The objective is to determine the unknown xrk that will be the total transportation cost while satisfying all the supply and demand constraints

V. Numerical examples:

From Navi-Mumbai, specifics of the numerical problem have been gathered. Since the contributor wanted to keep the company's details private, we have not included them here.

Tables: Both table details were gathered for a month

Table :1

Plants	Supply [Heavy Vehicles]
A	20
B	50
C	50
TOTAL	120

Table 1 represents the quantity available in these plants

Table:2

Warehouses	Demand
X	10
Y	6
Z	14
TOTAL	30

Table 2 represents the demand for warehouses in various places.

VI. Formulation and Tables:

We create a transportation issue for XYZ Company since it is the primary resource. To find the best option and reduce the cost of transportation, we use the transportation model as shown below.

Table:3

TO/FROM	X	Y	Z	SUPPLY
A	8	10	20	20
B	40	30	55	50
C	20	25	35	50
DEMAND	10	6	14	30/120

If we can see the problem, Σ ar= 120, Σ bk = 30. Since Σar ≠ Σbk the problem is a type of unbalanced. Firstly, will balance the problem by adding a dummy warehouse "D". So will add 90 quantities with zero cost as a dummy.

Table:4

TO/FROM	X	Y	Z	D	SUPPLY
A	8	10 **6**	20 **14**	0	20
B	40	30	55	0 **50**	50
C	20 **10**	25	35	0 **40**	50
DEMAND	10	6	14	90	120

From Vogel's Approximation method [VAM], we find several occupied cells is 6 which is equal to m+n-1. Then we get the initial feasible solution as X12 =06, X13=14, X24 =50, X31=10, X34=40

The Optimistic transportation cost is Rs 540,000

VII. Linear Programming Problem Formulation of TP:

Now we are converting the transportation problem into a Linear programming problem by using table 4

Minimize:

Z=8X11+10X12+20X13+40X21+30X22+55X23+20X31+ 25X32+35X33

Subject to constraint:

X11 + X12 + X13 ≤ 20 …………………(I)
X21 + X22+ X23 ≤ 50 …………………(II)
X31 + X32 + X33 ≤ 50…………………(III)
X11 + X21 + X31 ≥ 10…………………(IV)
X12 + X22 + X32 ≥ 6…………………...(V)
X13 + X23+ X33 ≥14 …………………(VI)
X11, X12, X13, X21, X22, X23, X31, X32, X33 ≥ 0

Firstly, we change the problem in integer programming and using r Software on Integer Programming Formulation of Transportation Problem we are getting the optimal solution of our transportation problem which solving for Albert David Company to reduce transportation cost Rs 540,000 at X12 = 6, X13 = 14, X31 = 10

VIII. Conclusion:

We have proven the exclusivity and existence of the best possible solution to the transportation issue for the XYZ Company. This has been demonstrated through the development of the transportation problem into an integer programming problem, the application of the discussed methods in the paper, which produces the same optimal solution, and the articulation of the problem's optimality requirements. Additionally, the Branch and Bound approach yields the same outcome as VAM.

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