

# Mixed Constraints Cost Minimization Transportation Problem: An Effective Algorithmic Approach

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**Abstract** In the literature, there are several methods for finding an initial basic feasible solution to the cost-minimizing transportation problem with equality constraints. In this paper, we proposed an efficient algorithm for solving transportation problems in which the origin and destination constraints consist not only of equality but also inequality. The proposed method is easy to understand and to apply for finding an initial basic feasible solution to transportation problems happening in real-life situations.

**Keywords** Transportation problem (TP), Cost Minimization Transportation Problem with Mixed Constraints (CMTP-MC), Initial Basic Feasible Solution (IBFS)

## 1. Introduction

The transportation problem (TP) is a special class of linear programming problems, which deals with shipping commodities from sources to destinations. The transportation problem is to find the amount of commodity which should be transported from each source to each destination satisfying all the supply and demand limits of sources and destinations respectively so that the overall transporting cost is minimum which the objective of the TP. If the total supply and demand limits are equal, then the problem is said to be a balanced transportation problem with equality constraints.

The transportation problem was formalized by the French Mathematician Monge, [1]. Major advances were made in the field during World War II by the Russian Mathematician and Economist Leonid Vitaliyevich Kantorovich [2]. The standard form of the transportation problem was first presented by Frank Lauren Hitchcock [3]. Efficient methods of solution were derived by T. C. Koopman [4], Danzig, G.B., [5], and then by Charnes A. et al. [6-8].

Many researchers developed a lot of methods to solve the Transportation problem. Some recent research work I mentioned here, Babu et al. [9] demonstrate that Vogel's Approximation Method (VAM) has some limitations and computational blunders. To overcome these limitations, they developed an Improved Vogel's Approximation Method (IVAM) by correcting these blunders.

Baidya [10] develop the stochastic solid transportation models to minimize the total transport time and ensuring safety with the safety and time objective functions. Dash and Mohanty et al. [11] inspect the TP where unit transportation cost, supplies, and demands are measured as uncertain normal variables. They develop the conceptual uncertain programming model for TP which is converted to a deterministic linear programming model. Sometimes per unit transport cost is uncertain due to the unstable condition of the fuel market. Gupta and Arora [12] provide an algorithm for determining the minimum unit transportation cost in a capacitated transportation problem with bounds on rim conditions. Ahmad and Adhami [13] develop a couple of mathematical optimization models to obtain the lower and upper bounds of the TP, where the supplies and demands quantities vary in an interval. Some transport systems impose a certain charge to use their routes along with the transport cost. Khurana and Adlakha [14] propose an algorithm for solving a multi-index fixed charge bi-criterion TP which minimizes the variable and fixed costs simultaneously to yield an optimal basic feasible solution. They also offer an algorithm to obtain an initial basic feasible solution of the multi-index TP.

If the capability of a supply is appreciably expanded/reduced and the requirement of a destination is also appreciably expanded/decreased, then the usual transportation system transformed to unequal transportation problem with mixed constraints. The special type of transportation problem with mixed constraints was meticulously studied firstly by Brügden [15]. He solved this problem by considering a related standard transportation problem having two additional sources and two additional

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# Solving Transportation Problems With Mixed Constraints

**RJ Alexander**



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## **Table of Contents Solving Transportation Problems With Mixed Constraints**

1. Understanding the eBook Solving Transportation Problems With Mixed Constraints
  - The Rise of Digital Reading Solving Transportation Problems With Mixed Constraints
  - Advantages of eBooks Over Traditional Books
2. Identifying Solving Transportation Problems With Mixed Constraints
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Solving Transportation Problems With Mixed Constraints
  - User-Friendly Interface
4. Exploring eBook Recommendations from Solving Transportation Problems With Mixed Constraints
  - Personalized Recommendations
  - Solving Transportation Problems With Mixed Constraints User Reviews and Ratings
  - Solving Transportation Problems With Mixed Constraints and Bestseller Lists
5. Accessing Solving Transportation Problems With Mixed Constraints Free and Paid eBooks
  - Solving Transportation Problems With Mixed Constraints Public Domain eBooks
  - Solving Transportation Problems With Mixed Constraints eBook Subscription Services
  - Solving Transportation Problems With Mixed Constraints Budget-Friendly Options
6. Navigating Solving Transportation Problems With Mixed Constraints eBook Formats
  - ePub, PDF, MOBI, and More
  - Solving Transportation Problems With Mixed Constraints Compatibility with Devices
  - Solving Transportation Problems With Mixed Constraints Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Solving Transportation Problems With Mixed Constraints
  - Highlighting and Note-Taking Solving Transportation Problems With Mixed Constraints
  - Interactive Elements Solving Transportation Problems With Mixed Constraints
8. Staying Engaged with Solving Transportation Problems With Mixed Constraints

- Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Solving Transportation Problems With Mixed Constraints
9. Balancing eBooks and Physical Books Solving Transportation Problems With Mixed Constraints
- Benefits of a Digital Library
  - Creating a Diverse Reading Collection Solving Transportation Problems With Mixed Constraints
10. Overcoming Reading Challenges
- Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Solving Transportation Problems With Mixed Constraints
- Setting Reading Goals Solving Transportation Problems With Mixed Constraints
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Solving Transportation Problems With Mixed Constraints
- Fact-Checking eBook Content of Solving Transportation Problems With Mixed Constraints
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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web as a general trend vapor pressures of liquids at ambient temperatures increase with decreasing boiling points this is illustrated in the vapor pressure chart see right that shows graphs of the vapor pressures versus temperatures for a variety of liquids

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web the flow and heat transfer characteristics of china no 3 aviation kerosene in a heated curved tube under supercritical pressure are numerically investigated by a finite volume method

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web the vapor pressure of a liquid is defined as the pressure exerted by the molecules that escapes from the liquid to form a separate vapor phase above the liquid surface the pressure exerted by the vapor phase is called the vapor or saturation pressure vapor or saturation pressure depends on temperature

**13 10 vapor pressure curves chemistry libretexts** - Apr 02 2023

web sep 21 2022 a vapor pressure curve is a graph of vapor pressure as a function of temperature to find the normal boiling point of liquid a horizontal line is drawn from the y axis at a pressure equal to standard pressure

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web the graph of the vapor pressure of water versus temperature in figure page index 3 indicates that the vapor pressure of water is 68 kpa at about 90 c thus at about 90 c the vapor pressure of water will equal the atmospheric pressure in

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web nov 1 2003 droplet evaporation modeling by the distillation curve model accounting for kerosene fuel and elevated pressures

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web vapor pressure 0 1 psi at 100 f ntp 1992 vapor density relative to air 4 5 ntp 1992 heavier than air will sink specific gravity 0 8 at 59 f uscg 1999 less dense than water will float

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web in fact when the temperature increases from 20 to 60 c the vapor pressure of kerosene rises from 4 to 18 mbar 34 this

suggests that kerosene cannot be entirely vaporized at 60 c

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web kerosene icsc 0663 physical chemical information physical state appearance low viscosity liquid with characteristic odour physical dangers as a result of flow agitation etc electrostatic charges can be generated vapour pressure kpa at 37.8 c  
1.3.7 exposure health effects