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An Analysis of Transportation Issues in the Related Research

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Abstract: *Transportation problem nourishes economic and social activity and is cardinal to operations research and managementscience. This paper presents a limited survey on various types of transportation problem with its mathematical models.*

Keywords: Transportation problem, Bottleneck Transportation Problem, Multi-objective Transportation Problem

I. INTRODUCTION

One of the main focuses of operations research is transportation problems (TP), which has several applications in fields such as inventory management, communication networks, production planning, scheduling, personal allocation, and more. In logistics and supply chain management, transportation issues are crucial to cutting costs and enhancing service.

Organizations are under increasing pressure to discover more effective methods to produce and provide goods and services to consumers in the fiercely competitive market of today. It becomes harder to figure out how and when to provide the goods to clients in the amounts they want while still staying under budget. A strong foundation for addressing this topic is offered by transportation models.

They guarantee the timely and effective flow of raw materials and completed items. Finding the shipment schedule that satisfies supply limit and demand criteria while minimizing overall shipping costs is the goal of the transportation challenge. The structure of this document is as follows: A variety of transportation problems are covered in Section 2, including those involving cost minimization, cost minimization with mixed constraints, bottleneck transportation, and multi-objective transportation with mathematical models. The conclusions are covered in the final section.

Various Types of Transportation Problem

Cost Minimizing Transportation Problem (CMTP)

The goal of the transportation issue, known as the CMTP or Hitchock-Koopmann problem, is to identify the shipment schedule that minimizes the overall cost of shipping while meeting supply and demand constraints. In cases when the demand and supply quantities, together with the cost factors, are known, effective algorithms have been devised to solve transportation issues. The transportation problem's mathematical model was provided by Hitchcock (1941). The stepping stone approach was created by Charnes and Cooper in 1954 and offered an alternate technique for obtaining the information needed for the simplex method. Dantzig (1963) used the primal simplex transportation approach to transportation issues.Klein (1967) created a fundamental approach for minimum cash flows, which he applied to transportation and assignment difficulties. The transportation issue was also covered by Hadley (1972) in his book, Linear Programming. Goal programming was investigated by Lee (1972) and Ignizio (1976) as a means of solving TP. Kwak (1979) solved the better transportation issue using a goal programming methodology. Ahuja (1986) presented a minimax TP method. Currin (1986) conducted research on unacceptable paths in the TP. Sultan (1988) and Sultan and Goyal (1988) investigated the degeneracy in the transportation issue and its first fundamental practicable solution. A Simplex-type approach for a generic transportation issue was investigated by Arsham and Khan in 1989. An algorithm was presented by Kirca and Statir (1990) to find a first solution to the transportation issue.Krzysztof Goczyla spoke about a routing issue in the network of public transportation in 1995. Based on the notion of absolute point, Adlakha and Kowalski (1999) proposed an alternate solution method for a specific transportation issue. An O (cn2) heuristic was proposed by Sharma and K.D. Sharma (2000) to solve the uncapacitated transportation issue. Sun (2002) focused on the branch and bound method and exclusionary side restrictions transportation issue. Schrijver (2002) studied maximum flows and the history of transportation. Goal programming was used by Okunbor (2004) to address management decision making for transportation-related issues. A numerical application for the study and modeling of dynamical flexible systems in transportation was described by Żółkiewski (2008). Putcha (2009) created a technique that provides the transportation simplex algorithm with an appropriate amount of entries to begin. A methodical examination of load allocation was proposed by Adlakha and Kowalski (2009) in order to get a different optimum solution [7]. Immam et al. (2009) solved the transportation issue using an object-oriented model.The transportation issue for stochastic multi-period locations was examined by Klibiet al. (2010). (2010) Pandian and Natarajan presented a novel approach to determining the best course of action in transportation-related issues.

An enhanced variation of the VAM approach for transportation problems was suggested by Korukoglu and Balli (2011). Phase-II of the simplex approach was used by Sharma et al. (2011) to address the transportation challenge. Using the integer programming issue that Gaurav Sharma et al. (2012) presented to solve the transportation challenge. In 2012, Sudhakar et al. presented a novel method for determining the best solution to a transportation challenge. Optimization strategies for TP of three variables were covered by Rekha (2013). In order to identify an initial basic viable solution for both the balanced and unbalanced TP, Mollah Mesbahuddin Ahmedet al. (2014) devised an algorithm. Rekha et al. (2014) introduced a max min penalty technique to cost minimization transportation issue.Sarbjit Singh (2015) suggested a solution to the transportation problem's degeneracy.

Cost Minimizing Transportation Problem with Mixed Constraints

In practice, however, the majority of cost-minimization strategies for transportation problems include a variety of limitations that allow for the consideration of other applications beyond the domain of transportation, such as work scheduling, production distribution, inventory control, allocation issues, and investment analysis. Due to the rigor necessary to answer these issues optimally, the CMTPs with mixed constraints are seldom discussed in the literature. When it is feasible to ship more total products for less (or equal) total cost while sending the same quantity or more from each origin and to each destination, maintaining all shipping costs non-negative, this is known as the more-for-less (MFL) paradox in a transportation dilemma. The more-for-less approach's main objective is to reduce overall costs rather than just maximizing the amount of cargo that is delivered. In TP, getting more for less is not an uncommon occurrence, and the current

The usefulness of identifying instances in which the paradoxical situation arises has been shown by literature (1998). A management may utilize the knowledge that an MFL scenario has occurred to determine which warehouse or plant capacity need to be enhanced and which markets need to be targeted. Theoretically, Charnes and Klingman (1971), Szwarc (1971), Appa (1973), Isermann (1982), and Charnes et al. (1987) have all discussed the MFL dilemma in the TP. Robb (1990) offered a logical justification for the transportation phenomenon. Gupta et al. (1992) and Arsham (1992) relaxed the restrictions and included additional slack variables to reach the MFL solution for the TP with mixed constraints. Their approach is laborious since it adds additional variables and necessitates solving sets of intricate equations, even if it produces the best MFL answer. Arora and Ahuja (2000) conducted a paradoxical study on a transportation issue with fixed charges. A heuristic approach to MFL in distribution-related issues was presented by Veena Adlakha and Kowalski (2001). A heuristic approach to solve transportation problems with mixed constraints was developed by Adlakha et al. (2006). Storoy (2007) investigated the transportation dilemma once again. The paradox in the linear plus fractional transportation issue was investigated by Joshi and Gupta (2010). The fourier technique was created by Pandian and Natrajan (2010a) to solve transportation issues with mixed constraints. They added a specified constraint to each removed variable after converting all of the constraints to less than or equal to types of constraints. A different approach to determining the best more-for-less solution of the transportation issue with mixed constraints was later described in a different study (2010b). A modified version of the VAM technique was presented by Radindra Nath and Hossain (2012) as a solution to TPs with mixed constraints in MFL paradoxical situations. The identification of the more-for-less dilemma in the linear fractional transportation issue using an objective matrix was the subject of a 2012 discussion by Vishwas Deep Joshi and Nilama Gupta. The route approach was established by Pandian and Anuradha

(2013) to discover an MFL optimum solution to a TP. If paradox exists in a linear transportation issue, Osuji George et al. (2014) described an effective statistical approach for calculating it. A novel method for determining the cost sensitivity analysis, which establishes the interval of perturbation to maintain the existing more-for-less (MFL) optimum solution to the transportation issue ideal, was developed by Kavitha and Anuradha (2015). A modified version of the VAM approach was presented by Rabindra Nath et al. (2015) to solve TPs with mixed constraints in the MEL paradoxical condition.

Bottleneck Transportation Problem (BTP)

One particular kind of transportation difficulty is the bottleneck transportation problem, also known as the time-minimizing transportation problem, where each shipping route has a certain time period attached to it. Rather than reducing cost, the goal of this method is to reduce the maximum amount of time needed to transfer all supplies to their destinations. When perishable commodities are transported, emergency supplies are delivered, fire services are provided, or military forces need to be sent from their bases to the front lines, the BTP is encountered. When things are transported from origins to destinations as quickly as possible while meeting certain criteria at the destinations and source availability, a BTP is created. Hammer (1969) examined the classical issue in terms of time minimization. Hammer's issue was referred to as the bottleneck and time TPs. His challenge is to reduce the longest possible time needed to move commodities from supply sources to various demand destination destinations. Hammer's findings marked a substantial shift from previous TP research by taking time minimization into account. Hammer's issue was then further investigated by Garfinkel and Rao (1971), Szwarc (1971), Sharma and Swarup (1977, 1978), Seshan and Tikekar (1980), Khanna, Bakhsi and Arora (1983), and Isserman (1984) in an effort to provide more effective solutions. An ideal approach for 2 x n bottleneck transportation issues was presented by Ravi Varadarajan in 1991. In 2004, Sonia and Puri examined a two-tier hierarchical balanced time reducing technique.The overall transportation time issue in relation to the duration of active transportation routes was shown by Ilija Nikolic (2007). An method was presented in 2007 by Peerayuth Charnsethikul and Saeree Svetasreni to address two types of bottleneck transportation problems with an extra budget restriction. Two methods were devised by Pandian and Natarajan (2011): one to identify an optimum solution to a bottleneck-cost TP, and the other to locate all efficient solutions to a bottleneck-cost TP. In order to provide total transportation plans, Madhuri (2012) described the linear fractional time minimizing TP method with contaminants in the commodity. In order to calculate the shortest possible travel time, Sharif Uddin (2012) used a transportation algorithm. The time minimizing TP with fractional bottleneck objective function was covered by Jain and Saksena (2012). In 2015, Pavel Kolman put out a novel approach to reduce the amount of time required for transit from collecting locations to processing facilities.

Multi-objective Transportation Problem (MOTP)

The conventional goal of the linear programming transportation cost-minimization issue is to minimize the overall cost. Real-world issues are often modeled using many goals that are simultaneously in conflict and quantified on various scales. Multiple penalty criteria may occur simultaneously in many real-world scenarios, which forced researchers to consider and solve multi-objective transportation problems. For the multi-objective linear programming issue, several academics have created a number of ways, including the step method, the utility function method, interactive algorithms, fuzzy programming approach, lexicographic goal programming approach, and interval goal programming approach.

The goal programming technique was used by Lee and Moore (1973) to solve the multi-objective transportation issue. In 1979, Iserman introduced an algorithm that listed all of the efficient solutions to linear multi-objective transportation problems. Hyperbolic membership function was used by Leberling (1981) to solve a multi-objective linear programming issue. If there are k goals, Ringuest and Rinks (1987) suggested interactive methods to identify more than k non-dominated and dominated solutions. Thus, among the set of non-dominated options, the decision-maker must choose a compromise solution. Bit et al. (1992) demonstrated the use of fuzzy programming in conventional TP multicriteria decision making. An additive fuzzy programming approach was presented by Bit and Alam (1993) to solve the multi-objective transportation issue. In order to solve the multi-objective TP, Verma et al. (1997) defined a unique class of non-linear membership functions. A spanning tree-based genetic strategy for addressing a multi-objective transportation issue was described by Mistuo et al. [1999]. Hussien (1998) examined the whole set of -potentially efficient solutions of multi-objective TP with possibilistic coefficients of the objective functions. Das et al. (1999) solved the multi-objective interval transportation issue using a fuzzy programming technique. A fuzzy compromise programming method for multi-objective TP was examined by Li and Lai (2000). Under fuzziness, Waiel F. and El-Wahed (2001) investigated the multi-objective transportation issue. The integer nonlinear goal programming technique has also been used by Ali et al. (2011a, 2011b) to the sample surveys issue and multi-objective reliability optimization. The stability and effective solutions of MOTP with fuzzy coefficients, fuzzy supply quantities, and/or fuzzy demand quantities were covered by Ammar and Youness (2005). An interactive fuzzy goal programming method was provided by Wahed and Lee (2006) to identify the favored compromise solution for the MOTP. The method's main goal is to minimize the worst upper bound in order to find a workable solution that approaches each objective function's best lower bound. Assuming that every objective function has a fuzzy goal, Zangiabadi and Maleki (2007) presented a fuzzy goal programming method to find the best compromise solution for the MOTP. To find a compromise MOTP solution, the approach focuses on reducing the negative deviation variables from 1. Surapati and Roy (2008) investigated the use of fuzzy goal programming with a priority based strategy to solve a MOTP using fuzzy coefficients. A fuzzy logic guided non-dominated sorting genetic algorithm was presented by Lau et al. (2009) as a solution to the MOTP, which addresses the optimization of vehicle routing when numerous items, multiple consumers, and different depots are taken into account. Lohgaonkar and Bajaj (2010) found the best compromise solution for a multi-objective capacitated problem using the fuzzy programming approach with linear and non-linear membership functions. T.P.Genetic algorithms were used by Sayed et al. (2012) to solve trans-shipment, assignment, and multi-objective transportation issues. Osuji et al. (2014) solved the multi-objective transportation issue using a fuzzy programming technique. A non-dominated point for the multi-objective transportation issue was provided by Abbas et al. (2015).

II. CONCLUSION

This paper gives a brief overview of a few different types of transportation problems, including those that try to minimize costs, those that try to minimize costs with a mix of limits, those that cause traffic jams, and those that have more than one goal and use mathematical models to solve them.

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