


Multi-Objective Optimization Methods for Transportation Network Problems: Definition, Taxonomy, and Annotation

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ABSTRACT

This article recapitulates literature research solving transportation problems and these variants, notably the multimodal transportation problems variants. Moreover, the existing optimization methods critiqued and synthesized their efficiency to solve the transportation problem. This problem can be identified by various criteria and objectives functions that distinguished according to the case study. Based on the existing literature research, a taxonomy is proposed to distinguish different factors and criteria that perform and influence the multi-objective optimization on the transportation network planning problems. The transportation problems are cited according to these objective functions, and the variant of the problem by referring to the previous studies. In this article, the authors have focused their attention on a recent multi-objective mathematical model to solve the planning network of the multimodal transportation problem.

KEYWORDS

Approach Methods, Exact Methods, Mathematical Programming, Multi-Modal Transport, Multi-Objective Optimization, Optimization Methods, Planning Network, Transportation Problems

INTRODUCTION

The transportation system defined as the displacement of the goods or passengers between two terminals or cities in the international or national network. The national and international networks include the conveyances, corresponding network, transportation mode, networks paths, itineraries, cities, depots, customers, stations, and terminals. The network defined by a set of nodes connected by one or more itineraries in the transportation system, each itinerary represents a transportation mode. The itinerary is represented by only one connection and one transportation mode between two nodes. The nodes are described as exchange stations that can include the transshipment, the delivery or the load and unload of the merchandise.

This article provides an overview of the literature researches based on the optimization of transport problem as well as the optimization methods applied to solve these problems in multi-objective and single objective case. The goal is to distinguish the objectives functions of the optimization transport

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problem to better satisfy the customer's demands. This satisfaction incorporates a set of objectives, such as minimizing the total cost of transport, the total time of transport or maximizing the quality of service, etc., in order to transfer the merchandise from a departure node to a destination node. These objectives are measured and evaluated differently according to the criteria and the parameters defined by the decision-maker depending on the case study.

The optimization methods and operations research play an important role in solving these problems. The role of the decision-maker is to adopt the optimization methodology or techniques to better optimize and solve the problem after having defined and modeled it. The modeling step consists to define the assumptions, the sets, and settings of the problem, the decision variables and the objectives functions that defined by the set of criteria and the set of constraints to be respected.

The aim of this paper is to recapitulate the existent optimization and resolution methods applied to solve the planning transportation networks problem, in order to help the decision-maker to identify the type of problem to be solved and to select the criteria to be optimized.

The structure of this paper is organized as follows: Section 2 outlines a classification relying on the existent characteristics of transportation problems and presents a taxonomy of objectives functions based on optimization and transportation problems. Section 3 discusses an overview of the modeling and resolution method that solves the most common transportation problems by means of a single objective. Section 4 discusses an overview of the modeling and resolution methods that solve the principal transportation problems using multiple objectives. This section ends with a synthesis and criticizes main literature researches. Section 5 focuses on a survey of the existent researches dealing with multimodal transportation problems and defining their main extensions. This section is split into three sub-sections, i.e., the single objective optimization problems, the multi-objective optimization and ultimately, a critical comment, which is discussed. Besides, a multi-objective mathematical formulation is cited. Correspondingly, the readers are referred to (Mnif & Bouamama, 2017b, 2017a). Finally, section 6 concludes with a summary and suggests some future research directions.

TAXONOMY

Extensions of Transportation Problems

Taxonomy is based on some existing researches to transportation issues and their extensions. In fact, the literature works refer to this taxonomy. It distinguishes the various characteristics of the transportation problems (see Table 1) and the various criteria that define the objectives functions considered, in the literature, to solve the transportation problems (see Table 2). These objectives functions are defined and expressed in different ways according to the criteria fixed based on the types of treated problem. However, these objectives are generally contradictory. The main objectives of transportation problems distinguished in this study, are summarized in Table 2, including the minimization of the cost, the minimization of the duration of the transport, the maximization of profit, the maximization of service quality, and the satisfaction of customers in terms of the time windows when visited by the customers.

This paper presents a taxonomy based on a sample of 50 articles of researches works. This taxonomy distinguishes the various objectives functions and defines their possible criteria and parameters. The objectives can be measured in different ways. In fact, the objective to minimize the total transport time can be determined in terms of the delay time, the service time, the transshipment time, the waiting time, etc. This taxonomy discerned various objectives treated for transportation network problems. The main objectives of transportation problems are summarized in terms transportation costs (27 articles), travel time (18 articles), risk (3 articles), distance (4 articles) and capacity (2 articles). Other articles were addressed to satisfy the demand, to maximize the service quality and to guarantee the accessibility of demand (5 articles). The majority of researches dealing with the optimization of transportation problems are interested in minimizing the total transport cost as the main objective.

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