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Multi-Objective Green Vehicle Routing Problem with Multi-Machine and Fuel Constraint

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Abstract*— Nowadays the managements of supply chain are faced with lots of environmental problems such as the erosion of biodiversity, the exhaustion of resources, the disorder of climate, the affection of human health by pollution and so on, as a result of industrial development and human unconsciousness. On the other hand, transportation plays a critical role in constructing disorder of climate which is a very important environmental problem. Therefore, this paper is proposed to integrate the environmental impacts into the transport function within the Vehicle Routing Problem (VRP). Moreover, in this paper, a Green Vehicle Routing Problem (G-VRP) is formulated and solution techniques are developed with respect to limited vehicle driving range in conjunction with limited refueling infrastructure and vehicle container constraint. The G-VRP is formulated as a mixed integer linear program and then two meta-heuristic algorithms, Multi-Objective Memetic Algorithm (MO-MA) and Multi-Objective Simulated Annealing (MO-SA) are developed to solve the proposed model. Finally, results of numerical experiments show that the MO-MA is more efficient than MO-SA.

Keywords- Green vehicle routing problem, Fuel tank capacity limitation, Vehicle container capacity limitation.

I. INTRODUCTION

In recent years, manufacturing organizations have recognized the importance of their supply chain partners in the management of the natural environment. For example, major manufacturers around the world have developed and implemented comprehensive programs to control and improve their environmental practices across the entire supply chain [1]. These programs imply environment-related interactions with upstream suppliers and, usually to a lesser extent, with downstream customers. They include several activities, such as managing reverse flows of materials and packaging [2], sharing environmental management techniques and knowledge among supply chain partners [1], controlling environmental risk associated with suppliers' operations, and assuring proper product utilization by customers [3]. Ultimately, such activities with the suppliers or with the customers can affect environmental management decisions within any particular manufacturing plant. Another issue which can affect environmental management decisions is transportation, a large part of supply chain and logistic, incurring high amount of environmental pollution such as air pollution, noise pollution, and accident risk. In the United States (US), the transportation sector contributes 28% of national greenhouse gas (GHG) emissions [4]. This is in large part because 97% of US transportation energy comes from petroleum-based fuels [5]. Efforts have been made over many decades to attract drivers away from personal automobiles and onto public transit and freight from trucks to rail. Such efforts are aimed at reducing vehicle miles traveled by road and, thus, fossil-fuel usage. Other efforts have focused on introducing cleaner fuels, e.g. ultra low sulfur diesel, and efficient engine technologies, leading to reduced emissions for the same miles traveled and greater mileage per gallon of fuel used. Another helpful effort for reducing national greenhouse gas can be done by controlling the air pollution and noise pollution occurred by inappropriate transportation in supply chain network. Therefore, in this study, a vehicle routing problem as a standard problem in transportation knowledge is considered along with its environmental impacts. The goal of this study is to propose a new mathematical model in vehicle routing problem with two objective functions: minimization of air pollution and minimization of noise pollution. Fuel tank capacity limitation and vehicle container capacity limitation are also considered in the proposed model. The literature below describes the studies considering fuel tank capacity limitation. The approaches studied in the following researches are different from our approach.

A number of works in the literature present optimization-based approaches designed specifically for siting fuel stations. The majority of these works were