Chapter 29
Location Planning of Electric Vehicles Charging Stations

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ABSTRACT

In this chapter, the authors address the problem of location planning of recharging stations for electric vehicles. This involves determining the best locations for charging stations in order to ensure that vehicles are charged enough for rendering a service when needed. The problem objective is to maximize the flow coverage for the electric vehicles through optimizing the number of recharging stations and their specific type at each station. Flow coverage is referred to as the ratio of car flows that are covered with regard to a special budget level. It also tries to minimize the locating cost related to these infrastructures. A genetic algorithm-based approach is proposed. Numerical application is provided, and results compared against branch and cut algorithm. The proposed approach performs better.

1. INTRODUCTION

Nowadays, many governments are involved in reducing air pollution arising from vehicle movements and saving energy at the same time, especially in big cities where it can be a big dilemma (Wang and Linn, 2013). Transportation management is one of the fundamental processes in maintaining sustainable and green supply chain (Tundys, 2017). Using public transport is a good alternative to personal cars; however, it is not applicable at all the times.

Using shared cars is another alternative to this problem, which lets users have their personal privacy. It also decreases the number of cars on the streets. It is also a good alternative for doing urban trips.

There is even a better solution to this problem, i.e. using electric vehicles in the carsharing companies as an alternative to fossil fuel-based vehicles. In this way, they can reduce the fuel consumption and decrease the air pollution significantly.

There are some challenges regarding electric vehicles usage which currently limits their application in carsharing companies. Planning of supply chain activities is one of the most important enablers in initiating an efficient collaboration between logistics partners. Efficient resource planning will result in

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lean supply chain management and eliminates the waste in time and money. This is the key in realization of business goals and profit management (Grzybowska et al., 2014).

In the context of electric vehicles usage in carsharing industry, facility planning is one of the main concerns in supply chain planning activities. It is defined as the process of identifying the location, number and types of facilities to meet the customer needs as well as the business needs. Sustainable planning is a crucial factor in obtaining environmental objectives (Awasthi et al., 2014). Selecting the most efficient and economic growth strategy, while satisfying the demand, has always been a big challenge on the way of carsharing companies (El Fassi et al., 2012). It specially comes in to attention when we are talking about electric vehicles. Operational and constructional costs of green supply chain have always been a concern in initiating green supply chain strategies (Tundys, 2017).

Considering the charging limit of battery of an electric vehicle and its energy consumption during trip, drivers can think of various charging strategies such as charging the vehicle in the middle of the trip in order to avoid running out of electricity charge (Wang and Lin, 2013). Facing these challenges needs more in-depth studies in order to investigate the best solutions and possible approaches to deal with this issue (Kuby and Lim, 2005).

In this paper, we perform a study on one of the main challenges in carsharing industry which is location planning for charging stations of Electric Vehicles. This involves determining the best locations for placing charging stations for electric vehicles in order to ensure that vehicles are charged enough for rendering a service when needed.

The mathematical problem objective is to maximize the flow coverage for the electric vehicles through optimizing the number of recharging stations and their specific recharging technology type at each station. Flow coverage is referred to the ratio of car flows that are covered with regard to a special budget level. It also tries to minimize the locating cost related to these infrastructures. Our work is based on the model developed by Wang and Lin, 2013. We implement the improved version of the problem through branch and cut algorithm in AIMMS (Advanced Interactive Multidimensional Modeling System) and Genetic Algorithm in Matlab. The results of our model show superior performance over the original model.

The rest of the paper is organized as follows. In section 2, represents the problem statement. In section 3, we present the literature review on electric vehicles carsharing, issues in managing electric vehicles fleet, and location planning in this industry. Section 4 includes proposed solution approach for location planning problem for the recharging stations. Section 5 represents and compares the achieved results. Section 6 presents the conclusions and future works.

2. PROBLEM STATEMENT

Battery power limitations in electric vehicles forces the drivers to keep their cars charged at all the times. Therefore, finding a re-charging station for these drivers can be a very important concern in order to complete their trip and also for companies to respond to their customers' needs. Considering budgetary constraints, finding the right number of required charging stations and also installing them in the right places so that they can be accessible for all customers are some of the challenges that carsharing companies need to address. The paths and trips with more demands could be the base for the company to make the distribution of stations, but the question is how to use this information for this purpose.

The challenges in location planning of recharging stations for EVs (Electric Vehicles) is not limited to finding the right locations and number of the stations to be installed, but also other issues such as