A Multi-Objective and Multi-Product Advertising Billboard Location Model with Attraction Factor Mathematical Modeling and Solutions

Reza Lotfi, Department of Industrial Engineering, Yazd University, Yazd, Iran
Yahia Zare Mehrjerdi, Department of Industrial Engineering, Yazd University, Yazd, Iran
Nooshin Mardani, Islamic Azad University Takestan, Tehran, Iran

ABSTRACT
Location of advertising is one of the most important factors of marketing strategy, as finding the best location to install advertising billboards can have a major impact on profitability of the entire marketing process. This paper provides a billboard location model, which can determine the optimal locations for installing such billboards. The multi-objective and multi-product model developed for this purpose has two objective functions: optimizing the sales profit minus the costs of designing and installing the billboards, and attracting most visitors through maximization of an attraction factor. The designing cost is assumed to be associated with the attraction factor. This model finds the best location of billboards based on constraint such as number of visits and sales volume. Finally, a set of small and large-scale numerical examples are solved by implementing the solution method in GAMS\Cplex solver software. To solve the large-scale variants of the problem, the genetic algorithm.

KEYWORDS
Advertising Billboard, Genetic Algorithm, Location, Multi-Objective, Multi-Product

1. INTRODUCTION
A server can be used for gathering some required information such as costs, expenditures for attracting the potential visitors, well-designed billboards, and other limitations through the advertisement messages. The information obtained through analyzing the messages can contribute to increasing the profits or popularizing a brand by helping the advertiser to decide about the optimal advertising budget and how to allocate that budget to different media and marketing factors such as agents, programs and advertisement spaces (Baluja, 2011). According to Apple (2006), generic advertising plays an important role in the production procedure. The advertisers often use one or a combination of four traditional media, i.e. television, radio, print, and outdoor advertising for marketing (Pritchett et al., 1998) but the latter is one of the most economic methods of advertising, as it allows the message to reach out to people with minimum cost (Jimenez, 2013).
As Taylor et al. (2006) have stated, billboards which pop up in different sizes and shapes along highways and main streets, are the most common type of outdoor advertisement. Placing advertising billboards in cities have a number of advantages, for example all passing pedestrians and drivers can see them easily all the time; advertisers can install the billboards near the location of sale, so it can contribute to selling the local products; the size of advertisement can enhance its effects; and advertisers can also use the size and shape of billboards creatively to maximize the effect on visitors. According to researchers on this subject, all above factors can help advertisers to attract more people, run a successful marketing campaign and thereby increase the profits.

It should also be noted that the billboards installed in main streets may induce some dangers through distracting drivers and reduce their driving performance, which might be particularly dangerous for elders and inexperienced drivers. A driver who stares at a billboard may not have the sufficiently fast reflexes to respond to signs or dangers (Edquist et al., 2011).

This paper provides a billboard location model, which can determine the optimal locations for installing such billboards. The multi-objective and multi-product model developed for this purpose has two objective functions: optimizing the sales profit minus the costs of designing and installing the billboards, and attracting most visitors through maximization of an attraction factor. The designing cost is assumed to be associated with the attraction factor. This model finds the best location of billboards based on constraints such as the number of visits and sales volume. Finally, a set of small and large-scale numerical examples are solved by implementing the solution method in GAMS\Cplex solver software. To solve the large-scale variants of the problem, the genetic algorithm, which is the most common algorithm for solving integer programming problems of this size, is developed.

The rest of the paper is organized as follows. Section 2 describes the problem. Section 3 presents the formulation of the mathematical problem. Section 4 presents the proposed solution algorithms. Section 5 evaluates the model and the solution algorithms with numerical examples. Finally, Section 6 concludes the paper and provides some suggestions for future research.

2. LITERATURE REVIEW

The tasks of facility location and demand allocation fall into the domain of work of Location-allocation (LA) models, which can perform such tasks for many types of services and products (Hodgson et al., 1993). The most popular types of optimization objectives in the literature dedicated to these models are distance-minimizing or demand-covering ones. In these models, demand is often defined with points at which customers start to travel to gain access to facilities, or the points at which vehicles start to travel to serve customers. However, as Hodgson (1998) has pointed out, demands can be flow-based, i.e. based on the flow of customers traveling on a pre-determined path, instead of being focused and centered around points.

One notable work in the literature of billboard location model is the flow-capturing model introduced by Hodgson (1990). The flow-capturing models are focused on the location of facilities for which demand is flow-based, and server may be congested. The examples of these facilities are gas stations, convenience stores, and billboards. In the model developed by Hodgson (1990), which was focused on flow-capturing location-allocation problem in the context of the transportation network, all flows between each origin-destination (OD) pair was assumed to be on the same minimum path.

Later, Berman et al. (1992) developed the Hodgson’s model into another model for optimal facility location with the aim of covering maximum potential flow of customers. However, the simple issue of competition between facilities of the same chain was ignored.

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