International Journal of Operations Research and Information Systems
Volume 14 • Issue 1

Firefighting Stations Allocation Model for the State of Kuwait

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ABSTRACT

The objective is to determine the best re-allocations of the stations to easily reach the accident location with both the least cost and time possible, with the best firefighting effective required facilities. This objective required dividing the six governorates into 133 areas served in 6 minutes efficient response time. The final findings of this study were 30 reallocated stations, which managed effectively to cover all 133 required areas. This has been shown on included maps of the six governorates. The goal linear programming model idea was not discussed in the emergency field research of the "State of Kuwait," specifically in the firefighting emergency service. Moreover, this modeling can be expanded to cover all other types of emergency service topics such as health, paramedics, and police stations.

KEYWORDS

Emergency Services, Goal Linear Programming Model, Optimal Allocation

INTRODUCTION

This paper is basically focused on a firefighting service in the state of Kuwait, for which we are about to use the mathematical model of the service based on the firefighting stations' location. We consider the firefighting service as a continuous and necessary human-threat risk management that depends on fatal time management. The latter also requires the ease of information accuracy flow from the source of a tragic incident (emergency location) to an emergency call center "211," which is a high-tech recipient to ease and shorten the response time of the closest firefighting station to the emergency incident location.

The "Kuwait Firefighting Service Department," so-called, had "38" active firefighting stations by the year 2013, according to their annual statistical reports published in their official homepage back then (www.kfsd.gov.kw). But, according to our research methodology, we end up with "30" working firefighting stations for the required emergency location service. We asked for the response time to not exceed 6 minutes to rescue and help in life threat situations.

Nowadays, the name "Kuwait Firefighting Service Department" has been changed by the year 2020 to "Kuwait Firefighting Force" with the updated homepage (www.kff.gov.kw).

DOI: 10.4018/IJORIS.334126 *Corresponding Author

LITERATURE REVIEW

Emergency service is defined as "an emergency service and/or repair given by the medical, firefighting, and/or police facilities in both private or public sectors." This definition was given by Marianov (2017), Santiago, Chile.

The emergency service is an old topic and a necessity that aids to pause threats to rescue lives or properties. When the properties are considered in the emergency location service (ELS), a study in Spain conducted by Silva with Serra (2008) shows that the degree of danger and human life threats should have a higher priority than routine incidents calls or emergency service.

In a study in East Asia (Japan), the transfer time of patients to hospitals had the priority. So, the study considered transfer-time minimization as an emergency project management (EMG) situation. Accordingly, the latter shows the essential role of ambulances, paramedics, and hospital staff (Sonoda & Ishibai, 2015).

Japan has been considered one of the most famous countries in natural (earthquakes) or man-made disasters since 1950. Those disasters are exponentially increasing with the emergency facilities' location, as mentioned by the authors Boonmee et al. (2017). They proposed the facility location optimization model to meet the emergency humanitarian needs.

Moreover, relating to the emergency threat demand in China, such as demographic growth in China besides natural disasters, the importance of the coverage of the response time rises up. So, Yuhan and Jie (2019) suggested a multicoverage optimal location model for emergency medical services (EMS) facilities. This suggestion focused on finding a scientific solution that adds a valuable travel time (minutes) to overcome rescue difficulty. This shows that the facility location plays an efficient role in response time to rescue lives or properties. Another study from China mentioned that the necessity of modeling came from the emergency service demands that urge the importance of facilities' location, which proposed a model called the robust optimization approach to emergency mobile facility routing (Li et al., 2020). Furthermore, an infrastructure restoration network plan is more crucially required when natural/man-made disasters are mentioned. This suggested the study from the United States of America (Iloglu & Albert, 2019) that uses a maximal multiple coverage and network restoration model to help emergency managers to schedule 1) effective restoration activities on the actual disaster time and 2) long-term recovery planning.

One of the optimization approaches is an advanced life support (ALS) optimization model, which was used in Thailand for an ambulance facility location problem. This model was proposed by Sumrit and Thongsiriruengchai (2020) when trying to minimize the arrival time of the ambulance to be less than "8 minutes" in Bangkok, Thailand. This was achieved by the availability location of the parking area to meet the rescue service time.

Another approach called a biobjective (deterministic and probabilistic) approach was used in Brazil (Belo Horizonte) by de Oliveira et al. (2020). The study findings had been applied on the facility location problem in EMS for coverage demand in Belo Horizonte, Brazil.

Finally, if the uncertainty is related and considered for ELS, an applied mathematical model has been suggested by Zokaee et al. (2016). This study was held in the Alborz area in the Tehran province of Iran because this area is totally vulnerable and has an uncertain cost factor for earthquakes. The authors used a three-level relief humanitarian logistics chain between suppliers, distribution centers, and affected areas. Uncertainty rises or relates to the cost of demand and supply besides any related parameters. The proposed model aims to maximize the people satisfaction in the affected areas as well as minimize the total cost of the relief chain.

Regarding the Arabian Gulf countries encountered research history, it was advisable to look for the research that shed a light on the goal programming for service, which happened to be a good opportunity to find it under the title of "the traffic portal vehicles allocation model for Riyadh" (Algadhi & Hasan, 1994). So, I found that we may consider a parallel effort in the State of Kuwait regarding emergency service, which is the goal of this study to apply the allocation method of goal