

# Multi Objective Location Routing Inventory Problem With Time Windows

**Mahdi Bashiri, Ehsan Fallahzade**

*Department of industrial engineering, Shahed University, Bashiri@shahed.ac.ir*  
*Department of industrial engineering, Shahed University, e.fallahzade@shahed.ac.ir*

## Abstract

The location routing inventory problem (LRIP) involves selecting central depots from a set of candidates and designing a set of routes for each depot to serve customers, while minimizing total distribution and inventory costs. In order to consider other decision factors beside cost and make the problem more practical, multi objective approaches seems to be useful. This study considers the time intervals that customers must be served known as hard time windows, the time intervals that the customers like to be served known as soft time windows and also the model considers avoiding underutilization of vehicles capacity and labor. We are going to investigate the use of goal programming approach to model these problems.

**Keywords:** Location routing inventory problem (LRIP); Time windows; Goal programming

## 1. Introduction

Nowadays companies need to consider both strategic and operational decisions together in order to design and manage their supply chain more efficiently. Transportation and distribution of goods are most important segments of a supply chain. Well-managed transportation systems will guarantee not only a good service to customers but also reduction in distribution and warehousing costs.

The classic location routing problem consists of choosing appropriate location among candidates to locate the distribution center and to determine the best set of routes to serve the customers while minimizing the total cost. In the literature there are several studies that consider location routing and inventory decisions simultaneously. Among recent studies [1] and [2] presented incorporated location routing inventory problems. The objective functions of these studies are the sum of location, allocation, routing and inventory costs. Beside cost, another important factor is time. Some problems have predetermined time constraints on the period that deliveries should take place. These kinds of problems are known as the problems with Time windows. Two types of time windows exist, soft and hard; in soft time windows each customer has a preferred time interval and it like to be served in this interval. If the service reaches to the customer beyond this interval it will accept the service but with a specific penalty. However in problems with hard time window each customer has a predefined time interval and it will not accept the services which are out of this interval. There exist some comprehensive reviews among literature about these kinds of problems such as: [3] [4] [5] [6], [7] [8] [9].

In addition to minimizing total distribution cost and travel time, the real life transportation problems have other objectives such as avoiding underutilization of vehicle capacity or labor. Calvete et al. presents a multi objective vehicle routing problem (VRP) in which cost, time window and underutilization of vehicle capacity and labor are considered [10]. In this paper a multi objective location routing inventory model is going to be presented which considers location, allocation, and inventory costs; hard and soft time windows; avoiding underutilization of vehicle capacity and labor. Among the most useful multi objective methodologies, goal programming (GP) is popular. In GP an acceptable level for each goal will be defined as a target, and then the GP tries to minimize the deviation of objective functions from these targets [11], [12], [13]. There are two kinds of GP, weighted goal programming (WGP) and lexicographic (LGP). In LGP each goal gets a priority and they are going to be minimized one at a time in order of priority. In WGP deviation from each goal