

# Design and Management of Urban Bike Sharing Systems

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Recently, promotion of the urban bike sharing systems becomes a popular public policy in many countries due to Green Transportation. Velib in Paris is the most successful case. Similarly, Taipei and Kaohsiung respectively implement “YouBike” and “C-Bike”. This thesis investigates three major problems encountered in the design and management of urban bike sharing systems.

The first problem seeks the best locations of stations and number of bike stands to be built, which can be viewed as a specialized P-median Problem or Fixed Charge Location Problem, based on survey data which records hourly origin-destination preferences of commuters. We give an integer programming model, named as the Bike Sharing Network Design model (BSND), and two particle swarm optimization algorithms to solve the first problem.

The second problem, named as the Single-type Bike Redistribution model (STBR), deals with single-type bike redistribution planning that solves for the best deployment of bikes between bike-sharing stations to minimize the weighted sum of single-type bike redistribution costs and the commuting costs caused by the imbalance of bike supplies and commuters' demand. We give a minimum cost multicommodity network flow model, and then solve for the minimum number of distribution vehicles required by a minimum cost network flow model. Moreover, based on the viewpoints from the managers of bike sharing systems, we propose a single-objective model that only minimizes the bike redistribution costs while preserving a service level that guarantees the commuting costs to be bounded above by a specified factor to their minimum value.

The third problem, named as Multi-type Bike Redistribution model (MTBR), considers the required advertisement exposure rate at specific stations or on specific riding paths to deal with multi-type bike deployment planning that solves for the best deployment of bikes of each type between bike-sharing stations. By comparing MTBR with STBR, we can suggest the range of the advertisement charges to the managers for providing affordable bike sharing services. Some numerical examples are also conducted and illustrated to show how our models work.

**Keywords:** Urban bike sharing network, Network design, Fleet deployment and transportation, Bike redistribution, Multicommodity network flow

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