Optimal Station Allocation and Dynamic Bike Repositioning Strategies for Public Bike Sharing Systems

Ching-Peng Hung

Department of Industrial and Information Management

National Cheng Kung University

Recently, short-term bicycle rentals at a network of unmanned locations in metropolitan areas around the world become popular. A successful manager of a bike-sharing system has to decide suited location and capacity of a bike rental station, deploy the bike fleet, and conduct bike repositioning between stations in a way that minimizes the total cost while satisfying a given service level. This paper investigates two problems encountered in the design and management of urban public bike sharing systems. In order to better meet the real behavior of customers, the first network design problem considers different walking and riding time at every arc for different customer that obeys specific probability distribution. Based on the stochastic traveling time assumption, we propose a stochastic mixed integer model to decide the best station locations, capacity and amount of initial bicycles to be put for each station. We explain how to convert this problem as a Quadratic mixed integer program, which consumes much computational time by CPLEX. Then we propose two particle swarm optimization (PSO) algorithms to solve larger network design cases in shorter time.

Our second problem deals with a dynamic bike repositioning problem. In particular, with guarantees on the number of customers to be served and their total travel time not exceeding a specified threshold, we provide three specialized minimum cost multi-commodity network flow formulations based on different levels of available rental information. We recommend using our third formulation that assumes the customers follow historical trend of traveling, and seek the best route and repositioning decisions for each transit vehicle that travels between stations to load or unload bikes. Due to the complexity of the MIP formulation, we propose PSO algorithms to deal with dynamic bike repositioning problems of larger scale.

***Keywords*:** Bike-sharing system, network design, dynamic bike repositioning, multi-commodity network flow, particle swarm optimization

Thesis advisor: *I-Lin Wang*, ilinwang@mail.ncku.edu.tw
http://ilin.iim.ncku.edu.tw
***Ching-Peng Hung* entered IIM of NCKU in 2009, graduated in 2011.**