Pickup and Delivery Problem with Stochastic Travel Times for Semiconductor Supply Chains

Chun-Mei Lai

Department of Marketing and Logistics Management, Far East University
No.49, Zhonghua Rd., Xinshi Dist., Tainan City 74448, Taiwan, R.O.C.
chunmei@cc.feu.edu.tw

Abstract. As the supply chain has been constructed comprehensively, the pickup and delivery activities between supply-chain members are very frequently and complicated. In semiconductor factories, highly capacity utilization and efficiently production scheduling are essential due to the intensive capital investment. Because of travel time uncertainty, requests may fail to arrive within time window and may result in capacity idle and even deferral delivery when ignoring randomness of travel times. Therefore, taking the travel time uncertainty and time windows into account is of great importance when planning vehicle routes and schedules. Furthermore, in the fleet, some vehicles are with special facilities dedicated to carry 8” wafers, some are dedicated for 12” wafers, while other vehicles are open for carrying all products. When assigning requests to vehicles, the product/vehicle compatibility must be taken into account. In this study, we consider the pickup and delivery problem for semiconductor supply chains (PDPSSC), which involves constraints on stochastic travel times, time windows, product/vehicle compatibility, pickup and delivery, and vehicle capacity constraints. We describe the PDPSSC and formulate a chance constrained programming model to minimize total travel distances under two kinds of chance constraints, time windows and driver duration, hold with prescribed probabilities. By the implementation of the proposed model, the vehicle routing problem in semiconductor supply chain can be more integrated and applicable for the real-world applications.

Keywords: Pickup and delivery problem, stochastic travel time, time windows, semiconductor manufacturing.

INTRODUCTION

As a semiconductor supply becomes widespread and the competition pressure is very fierce, the cross-company supply chain operations are even more complicated such that a semiconductor manufacturer needs to integrate and manage distribution in supply chain networks effectively and efficiently to increase their competition edge and profitability (Dondo et al. 2008; Manzini and Bindi, 2009). In this study, we investigate the practical pickup and delivery problem under travel time uncertainty, which is often found in real-world practice, particularly, in semiconductor supply chains.

For vehicle routing problem with stochastic travel times, Laporte et al. (1992) consider the vehicle routing problem with stochastic travel times and presented three models: a chance constrained model, a 3-index simple recourse model, and a 2-index recourse model. A general branch and cut algorithm for three models is also proposed for solving large-scale problems. Kenyon and Morton (2003) tackle the stochastic vehicle routing problems with random travel and service times. In terms of different optimization criteria, two stochastic models are developed. A branch-and-cut scheme within a Monte Carlo sampling-based procedure is also proposed for solving the general-form problem. Rekiek et al. (2006) present a grouping genetic algorithm for solving the handicapped person transportation problem. Chang et al. (2009) formulate the JIT pickup/delivery problems as a stochastic dynamic traveling salesman problem with hard time windows and present a FAN algorithm for solving the SDTSPTW. Li et al. (2010) propose a chance constrained programming model and a stochastic programming model for solving the vehicle routing problems with time windows and stochastic travel and service times. A tabu-based algorithm is also proposed for solving the SVRPTW.

One of the importance classes of vehicle routing and scheduling problems is pickup and delivery problems, in which commodities or people have to be collected and distributed (Berbeglia, et al. 2007). In the pickup and delivery problem, a set of routes has to be constructed in order to satisfy transportation requests. Each vehicle has a given capacity, a start location, and an end location. Each transportation request specifies the size of the load to be transported, the locations where it is to be picked up and the locations where it is to be delivered. Each load has to be transported by one vehicle from its set of origins to its set of destinations without any transshipment at other locations (Savelsbergh and Sol, 1995). Very often, the pickup and/or delivery are imposed by time interval within