Solving the Multi-site Pickup and Delivery Problem

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Abstract. In order to increase a multi-site company's competition edge, the manufacturer needs to schedule vehicles for pickup and delivery effectively and efficiently because of the complexity and cost of transportation and distribution activities. This study considers the multi-site pickup and delivery problem (MPDP), which has many real-world applications, particularly, in the IC manufacturing industry. This study is motivated by a practical MPDP from a semiconductor manufacturing company. In the facility under study, transportation activities, arisen from pickup-and-delivery of wafer, mask, or finished-goods, are frequently and complicated. In addition, vehicle-scheduling decision for each request is based on its priority. Since the MPDP involves constraints on multiple-priority requests, pickup and delivery, multiple vehicles, and vehicle capacity constraints, it is more difficult to solve than the classical pickup and delivery problem. In this study, we consider the MPDP and formulate the MPDP as an integer programming problem to maximize the total completed activities in the planning period. An example is used to illustrate the performance of the proposed formulation.

Keywords: pickup and delivery, integer programming, multi-site, vehicle routing problem.

1. INTRODUCTION

Multi-site investment has been a popular way to increase capacity, particularly, in the semiconductor manufacturing industry. As a result, in many of today's multi-site companies, transportation and distribution activities emerge as one of the central issues owing to their complexity and costs. Due to the relative magnitude of the transportation and distribution costs is associated with the routing and scheduling of vehicles, enterprises have shown a growing interest for efficient vehicle-scheduling because of the good chance of getting large savings on such expenses (Stray et al. 2006; Dondo et al. 2008).

This study is motivated by a practical multi-site pickup and delivery problem (MPDP) from a semiconductor manufacturing company. In the facility under study, the production network consists of wafer fabs, mask houses, and one warehouse distributed in two Science Parks. There is one depot with fixed number of vehicles. Sites among each other are connected by transport. Transport requests arise from wafer delivery among fabs due to capacity backup, mask-delivery from mask house to fabs, material-delivery from warehouse to fabs and finished-goods from fabs to warehouse. In addition, there often exists more than one priority level of customer orders because of different product profit rates and the varied importance level of customers (Uzsoy et al. 1991; Freed and Leachman, 1999; Pearn et al. 2007). The actual schedule of those jobs with specified priority must be arranged following their specified priority. Higher priority is assigned to specific lots to reduce their cycle time. Because lots with different priorities have different processing priority, the various priority class lots also have a great influence on vehicle routing and scheduling. That is, multiple-priority scheduling decision will affect considerably the amount of time spend on vehicle routes.

In the MPDP, transport requests are known in advance. Each transport request specifies the amount of mask or wafer lots, the pickup locations (the origins), a time-interval for pickup, a time-interval for delivery, and the locations to be delivered (the destinations). Furthermore, each request needs to be operated by a single vehicle transporting lots from a specified origin to a specified destination without any transshipment. Each vehicle must start from the depot, visit a number of sites along the selected route, and return the depot. At each visit, the vehicle can perform pickup, delivery, or combined pickup and delivery without violating vehicle capacity restriction.

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