Chapter 7

SERVICE FACILITY LOCATION AND DESIGN WITH PRICING AND WAITING-TIME CONSIDERATIONS

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1. Introduction

The strategic role of effective supply chain design has been well recognized in recent years by both academics and practitioners (see, for example, Tayur et al. 1998). Locating and sizing facilities to serve customers is one aspect of supply chain design that presents a number of challenges, due to the recent emphasis on time-based competition. Customers are sensitive to the total cost of interacting with a firm’s service, including queuing time and access costs, in addition to price. Therefore, when setting up new service facilities, managers must carefully weigh capacity and location decisions, and choose an appropriate corresponding price. In this chapter, we formally address the interrelated location, capacity, and pricing decisions for a firm’s service facilities, via analytical (non-linear) optimization methodologies.

Several research streams have addressed a subset of these interrelated decisions by employing network optimization models. Network models
incorporating congestion effects address the impact of queuing delays on customers' waiting costs but ignore pricing concerns, focusing instead on minimizing customer travel times (e.g., see Bolch et al. 1998, and Daskin 1995 for comprehensive reviews of linear and non-linear facility location models). We will explore an alternative methodology for understanding the interdependent decisions related to service-facility design, in the presence of time sensitive customers and congestion delays. To gain managerial insights regarding the interactions among these important supply chain decisions and enhance our ability to generate solutions, we assume that consumers are continuously dispersed over a single location dimension (as in Hotelling’s 1929 "linear city" model), rather than employ a network representation of consumer locations. Relative to more detailed location models (e.g., a network topology), this approach permits us to analytically assess the structure of the firm's optimal pricing and capacity strategy. A related benefit is that we can perform comparative statics analysis to infer the direction of change in the optimal decision variables as problem parameters change. In addition, by simplifying the location model, we are able to extend the analysis to address both consumer segmentation and competition.

The location and capacity issues we address are especially relevant in settings for which service capacity is relatively expensive, implying that the firm cannot practically afford to install enough capacity to eliminate customer waiting. Businesses such as car wash/oil-change services, or tax preparation services, are representative contexts. In these examples, a consumer’s total transactions cost is influenced by both the inconvenience of traveling to the service facility, and the waiting time at the facility. The significance of the access and waiting costs, relative to the firm’s cost of capacity, will determine whether the firm’s strategy should employ many small facilities, rather than fewer, larger facilities. For example, if consumers’ access costs are high and the firm’s capacity costs are low, then the firm can maximize profits by creating relatively small facilities in close proximity to customers. Maximizing profits thus requires that the firm consider pricing in conjunction with the interrelated issues of facility-location and capacity.

In this chapter, we develop a modeling framework that provides insights regarding the firm’s location, capacity, and pricing decisions, for consumers who are sensitive to both waiting-time and transportation