

Chapter 16

Sourcing Decision in a Multi-Period Model Under Demand and Supply Uncertainty

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ABSTRACT

Determining the optimum number of suppliers and the optimum quantities to order from each of them is a critical problem for any supply chain. This paper has mathematically arrived at conditions to identify the appropriate sourcing strategy in a multi-period scenario for a stochastic supply and a stochastic demand environment. It has also obtained the total order quantity, optimum number of suppliers and order allocation to each of the suppliers under both uncertain demand and supply in the multiple-period context. Through a numerical analysis this work could bring interesting managerial insights about the sourcing strategies.

1. INTRODUCTION

Increasing product proliferation, shrinking product life cycles, demand for customized product, and business opportunities in a wider global market have induced enormous amount of uncertainties in the supply chains of the firms in the recent years. The uncertainty in the supply chain is not only due to the fluctuations in the demand but also due to inefficient production processes and unreliable supply sources (Lee and Billington, 1992; van der Vorst and Beulens, 2002). Supplier lead time, delivery performance and the quality of raw material are few of the major sources of supply side uncertainty. Supply uncertainties have direct impact on the inventory stocking and supplier selection policies that a firm adopts (Anupindi and Akella, 1993). For example, when the supply of a product with high stockout cost is uncertain then the firm will prefer a high amount of inventory holding (risk hedging strategy) (Lee, 2002). Similarly,

DOI: 10.4018/978-1-5225-3909-4.ch016

firms procure materials from multiple sources in order to mitigate the uncertainty arising from a single unreliable source (Anupindi and Akella, 1993).

Relying on multiple suppliers to avoid stockouts and improve the service levels have traditionally been the strategies of many supply chains. Supply chain literature also has convincingly argued that in most of the cases the use of multiple supply sources reduces overall inventory holding and distribution cost (Ganeshan, 1999; Minner, 2003). In the multiple supplier context the issues facing the purchasing managers are selecting a reliable set of suppliers and allocating order quantities to each of the selected supplier (Burke, Carrillo and Vakharia, 2007). Though firms select suppliers based on various assessment criteria such as cost or price (net price, discounts or payment terms), capacity, supplier service (reliability, lead time variability, delivery time and flexibility), and quality, cost becomes the primary selection criteria for most of the firms (Burke, Carrillo and Vakharia, 2009; Minner, 2003). Other selection criteria, which could be potential sources of supply uncertainty, are largely omitted. Selection of a set of supplier solely on the basis of price/cost may not ensure adequate order fill rate. Inadequate order fill rate from suppliers may arise for various reasons including supplier's inadequate capacity for a particular order, long transit time or inaccurate order scheduling by the suppliers. Irrespective of the reasons, there is always a chance that a particular supplier will not be able to deliver the ordered quantities and that in turn creates detrimental effects on the service level commitments of the buying firm. It is therefore pertinent to analyze the multiple supplier sourcing strategy in the context of supplier's service level uncertainties.

In this paper, the implications of uncertain supplier reliability on a firm's supplier selection criteria have been investigated. Here, in an environment where both demand and supply are uncertain, the total optimum order quantity, the optimum number of suppliers, the optimum order quantity to each of the selected supplier and the optimum amount of safety stock to be held has been derived in the context of multiple periods. Finally, a numerical analysis based on simulation is presented to substantiate the analytical findings.

2. LITERATURE REVIEW

In this paper, the main objective is to build a framework to address the problem of supplier sourcing in the presence of demand and supply uncertainty when multiple supplier option is available. Hence the relevant literature in this context can be divided into three loose categories. The first category would address how the researchers have modeled the presence of multiple suppliers in the classical profit-maximization or cost minimization framework. The second category would help us in modeling the uncertainty in supply by addressing the random yield problem. The last category would consist of the relevant studies which have been done in the context of multi-period scenario.

According to the literature, one of the methods to reduce supplier uncertainty is multiple sourcing (Lee, 2002). Researchers had already done comprehensive review on prior researches done in the field of supplier sourcing (Elmaghraby, 2000; Minner, 2003). Extensive comparison between the performances of single supplier strategy with multiple supplier strategy had also been done by the researchers (Van der Vorst and Beulens, 2002; Burke, Carrillo and Vakharia, 2007).

Ramasesh, Ord, Hayya and Pan (1991) were among the forerunners to study dual sourcing in a stochastic environment. The variable they assumed to be stochastic was the lead time taken by the supplier. They concluded that in presence of high uncertainty in lead time and low ordering cost, dual-supplier

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