Dual-Sourcing Inventory Management for Seasonal Products in the Fashion Industry

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Inventory control is a key decision for any firm since it helps to reduce the impact caused by the mismatch between supply and demand. Inventory holding may reduce product shortage and increase responsiveness. However, the excess of it could lead to higher holding costs and product obsolescence. It is particularly important for perishable products or seasonal goods. Products with a limited lifetime are highly affected by ordering decisions. For instance, in the fashion industry, several collections are launched during the year with short selling periods each. In these systems, production and supply must be exceptionally accurate in time and place to meet customers' requirements. It implies ordering the adequate quantity at each location aiming to avoid both overstocking and understocking. On the one hand, inventory shortage of these high-end goods may considerably impact the company's revenue and goodwill. On the other hand, inventory excess represents a loss of material, energy consumption, and the additional cost incurred for the final disposition of the unsold goods at the end of the season. In these particular environments, with short selling windows, and where stockouts imply very high costs, a proven strategy to deal with the pressure of meeting demand on time is the placement of emergency orders as a form of dual sourcing.

In the academic literature, dual sourcing might refer to a situation where a company has one main supplier from whom it sources products exclusively, but uses a backup supplier to mitigate the effects of potential disruptions, carrying with the extra cost of this decision [4]. It may also take the form of a decision between transportation speeds or transportation modes [5]. In this regard, it is considered the existence of a slow or periodic replenishment characterized by low cost, and a fast and costly replenishment able to supply in case of unforeseen fluctuations. This second form of dual sourcing is widespread in many industries. For example, some firms that use ocean freight for shipping on a regular basis might switch to the speedier and more expensive air freight in times of need [2]. The body of literature studying dual-sourcing supply has been growing over the last years, moving from small and restrictive models to larger and more realistic problems. In contrast to the majority of single-sourcing inventory models, in which optimal policies are known, optimal policies for dual-sourcing inventory models are either unknown or have a very complex structure and need to be defined individually regarding the parameters of the system [5].

Some previous works have addressed the problem of dual sourcing considering two available transportation modes: a slow mode with low cost and long and stochastic lead time, and a fast mode with higher cost and shorter and deterministic lead time. For instance, [6] considers the transport of car components under a limited budget for stock acquisition. The authors define a replenishment policy based on the safety stock and the expected demand during the lead time and present a simulation model for the periodic review inventory model. They conclude that in the long run term, extra costs for fast replenishment can be avoided by increasing safety stock. In [1] the effect of sea shipping lead time variability on the economic and environmental performance of inventory systems is evaluated. The authors deal with the problem as if it was an inventory system with lost sales, where every unit in stockout is supplied by an emergency order at a higher cost. They determine the order size using an EOQ model and compute the reorder point through simulation for two different objectives, minimization of total cost and minimization of emissions. These previous works assume an infinite horizon in which having a safety stock is a solution for the variability of the regular supplier. However, this strategy to deal with lead time variability might be not effective in the finite horizon, when inventory became useless and a penalty cost at the end of the selling season. In [3] the authors consider finite horizon to address the problem of alternative procurement for perishable agri-food products in the context of supply chain management risk. The regular supplier has a restriction on the minimum volume to deliver, while the alternative supplier can supply even low volumes in a short time at a higher price. A newsvendor model-type formulation is used to model the supply chain and to compute the optimal order size for each supplier aiming to maximize the expected profit. The authors show there is a boundary on the utilization of the alternative supplier that depends on the ratio between the procurement cost of the regular and the alternative supplier. To the best of our knowledge, no previous studies have addressed simultaneously the evaluation of dual-sourcing strategies in the finite horizon with uncertain lead time.

Motivated by the fashion industry, this work considers the inventory control of a single product with a finite selling season in a two-echelon supply chain, consisting of a central distribution center and an overseas depot. The central distribution center can replenish the regional depot multiple times during the selling season to meet the uncertain demand for the product. In particular, replenishment orders can be sent either by boat or by plane, each one having different transportation costs, lead times and different contributions regarding GHG emissions. Backorders are not allowed, and every stockout is considered a lost sale. Every unit left in inventory at the end of the season is disposed of for an additional cost. We formulate the problem as a stochastic dynamic programming model. We discuss the complexity of the problem, we present formulations for some variations of the original problem regarding alternatives for dual-sourcing use. We test the model utilizing industry data. We investigate the impact of the decision regarding environmental performance. Finally, we discuss the result of the models and present some managerial insights aiming at the definition of the inventory policy for the system.

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