Economic order quantity of a kitting process with stochastic demand and reordering times

Abstract

The economic order quantity model, developed by Harris in 1913, has been broadly applied in industry. The basic model allows for determining the replenishment strategy of an inventory which minimizes purchase, delivery and storage costs. While the single-part inventory problem is well understood, both in a deterministic and a stochastic setting, many issues of optimal inventory management in the multi-part inventory case remain unresolved, most prominently in the stochastic setting. Here, we focus on a two-product inventory management problem. Different purchase, delivery and storage costs are assumed for the parts, which leads to different optimal replenishment policies. Moreover, demand is completely coupled: this means that each demand requires both parts and can only be satisfied if both inventories are non-empty. This coupling is a natural assumption if the parts are assembled into a single product. Prior to assembly, parts are possibly collected into a kit container for reducing material handling time and enhancing product quality, hence the term kitting buffer is used. The inventory problem is studied in a Markovian setting. Reordering times are phase-type distributed while product demand is modeled by a Poisson process. If a part inventory is empty upon arrival of a demand, it cannot be satisfied immediately and the sale is lost. In terms of cost, we account for holding, shortage and purchase costs, the latter being an increasing concave function of the number of parts purchased. While no exact closed form formula can be found, computationally efficient numerical techniques are used which yield the cost of the inventory fast for any parameter setting. By numerical examples, we determine optimal reordering thresholds under various parameter settings.

Keywords

- Queuing Systems
- Production and Inventory Systems
- Stochastic Models