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A synchronized model for ordering, production and shipments lot sizing in a multi echelon supply chain*

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Abstract

The vast majority of the literature addressing the joint economic lot-sizing (JELS) decisions has dealt with the problem in the context of single-vendor, single-buyer supply chains. However, in reality, supply chain networks are more complex and involve more than just a vendor and a buyer. This paper presents a new integrated production–inventory model for a three layer supply chain composed of a supplier, a manufacturer and multi-retailers. The proposed model has the form of integrated procurement-production (IPP) systems as it also incorporates raw material procurement and manufacturing setup decisions. The timings and quantities for inbound and outbound logistics are specified for all parties involved such that the chain-wide total ordering, setup, raw material and finished product inventory holding costs are minimized. Although the model assumes equal sized shipments from an upstream member to the downstream one, different retailers might receive shipments of different sizes depending on each retailer's demand. Upon analysing the model, a closed form solution algorithm is developed based on differential calculus. The use of the proposed algorithm is illustrated through a numerical example.

Key words: Inventory, supply chain modelling, joint economic lot-sizing

1 Introduction

Inventory in manufacturing firms stands as an efficient tool to buffer against both demand volatility and supply uncertainty. Most firms, even those adopting the just-in-time (JIT) production philosophy, retain minimum levels of their products inventories at one stage or another of the manufacturing process. However, maintaining inventories entails an additional holding cost as well as opportunity cost since the money tied up in inventories could have been put for a better use. This brings out the need for a compromised policy that ensures the fulfillment of end customers' demand while keeping the holding cost, besides all other operational costs, at minimum. The Optimization of production and inventory related decisions is an issue that has long been dealt with in the literature. The customary practice is to identify the production and inventory policy that best serve the goals of the organization regardless of the impact such policy would have on its suppliers and customers. Due to the ever-increasing level of competitiveness and