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LOT SIZING, DELIVERY AND SCHEDULING OF IDENTICAL JOBS IN A SINGLE-STAGE SUPPLY CHAIN

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Abstract. *This article considers a particular batch scheduling problem with batch-size-dependent setup times. The objective of this problem is the determination of a production and transportation plan for a single-product case to meet the demand of the customer at minimum total costs. The costs may include production, transportation and holding costs. The problem is, in fact, the sum of two sub problems: a lot sizing problem and a scheduling problem. We show that the main problem is NP hard. Despite the complexity of the problem, we highlight a dominance property on the set of solutions that is the base of a very efficient dynamic programming scheme. Computational results illustrate the efficiency of the proposed algorithm in comparison with other similar approaches.*
Keywords: Batch scheduling, Capacitated lot-sizing, Production planning, Dynamic programming, Supply chain

1. **Introduction.** This paper addresses a batch-scheduling problem in a single-stage supply chain composed of a manufacturer, a transporter and a client. Jobs are assumed to be identical and have to be delivered before given due dates. The manufacturer processes the jobs on a serial batching machine with no setup time. All the jobs of a production batch are assumed to be completed at the end of the batch. As soon as the jobs are completed by the manufacturer, they can be loaded and delivered to a customer. In a supply chain context, the operations of loading and unloading the transporter are significant and dependent on the size of the load. They can be viewed as a setup operation for the delivery phase. In this case, the delivery of the jobs corresponds to a parallel batching process with a batch-size-dependent setup. The objective is to minimize the total cost, which encompasses the transportation and holding costs.

Batch scheduling problems (BSP), as well as lot sizing problems (LSP), have been studied widely these past decades, and moreover, they have proven to be equivalent under given conditions [1]. This growing interest is motivated by lower costs or more efficient production plans. When a machine setup is required for a production, batching is an efficient way to increase productivity.

Furthermore, more and more events affect the demand of the supply chain which may trigger the well-known bullwhip effect [2]. As a consequence, the consideration of a general demand, not only periodic but also non-periodic, is of major interest.

Several papers, like [3,4], review the main models and results in the field of the BSP. Several extensions have been proposed to allow the setup to be machine-dependent in [5,6] or sequence-dependent in [7,8] Among these works, some authors focus on the specific problem of batching identical jobs. In [9], Mosheiov minimizes the total flow-time of a single machine batch scheduling problem with batch-dependent setup time in $\mathcal{O}(n)$.