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Minimizing the weighted number of tardy jobs with due date assignment and capacity-constrained deliveries for multiple customers in supply chains

Morteza Rasti-Barzoki *, Seyed Reza Hejazi

Department of Industrial & Systems Engineering, Isfahan University of Technology, Isfahan 84156-8311, Iran

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ABSTRACT

In this paper, an integrated due date assignment and production and batch delivery scheduling problem for make-to-order production system and multiple customers is addressed. Consider a supply chain scheduling problem in which *n* orders (jobs) have to be scheduled on a single machine and delivered to *K* customers or to other machines for further processing in batches. A common due date is assigned to all the jobs of each customer and the number of jobs in delivery batches is constrained by the batch size. The objective is to minimize the sum of the total weighted number of tardy jobs, the total due date assignment costs and the total batch delivery costs. The problem is NP-hard. We formulate the problem as an Integer Programming (IP) model. Also, in this paper, a Heuristic Algorithm (HA) and a Branch and Bound (B&B) method for solving this problem are presented. Computational tests are used to demonstrate the efficiency of the developed methods.

1. Introduction

Supply Chain Management (SCM) is the management of material and information flows both in and between facilities, such as vendors, manufacturing and assembly plants and distribution centers (Thomas and Griffin, 1996). Scheduling models which consider inbound production and outbound deliveries simultaneously can improve the overall operational performance of the supply chains (Steiner and Zhang, 2011). Classical scheduling problems did not consider delivery costs, so considering both the delivery costs and scheduling objective is an important point that researchers have paid attention to recently. Production and distribution operations are two key operational functions in a supply chain. To achieve optimal operational performance in a supply chain, it is critical to integrate these two functions and plan and schedule them jointly in a coordinated manner (Chen, 2010). Chen (2010) reviewed the production and distribution scheduling models and classified these problems in five groups. Problems addressing an objective function that combines machine scheduling with the delivery costs are rather complex. However, they are more practical than those involving just one of the two factors, since these combined-optimization problems are often encountered when real-world supply chain management is considered. Yet, the body of literature on combined-optimization batch delivery problems is rather small (Mazdeh et al., 2011b). Hall and Potts (2003) considered the problem of scheduling the jobs on a single machine under the batch availability assumption with several objectives including the sum of flow times, the maximum lateness and the number of late jobs. One of the objectives that they considered was minimizing the weighted number of tardy jobs plus batch delivery costs. Slotnick and Sobel (2005) mentioned that the tardiness penalties in the aerospace industry may be as high as one million dollars per day for the suppliers of aircraft components.

On the other hand, one of the most important issues of supply chain scheduling is the way the due dates are considered: they can be given parameters or decision variables. The due date assignment problems arise in practice, when a firm offers a due date to its customers as a result of sale negotiations and has to offer a price reduction when the due date is considerably delayed (Gordon et al., 2002). The problems with due date determination have received considerable attention since the last two decades due to the introduction of new methods of inventory management such as just-in-time production system and supply chain management (Hsu et al., 2011). In traditional scheduling models, due dates are considered to be given as exogenous decisions. However, in an integrated system they are determined by taking into account the system's ability to meet the quoted delivery dates. For this reason, an increasing number of studies have viewed due date assignment as part of the scheduling process, showing how the ability to control due dates can be a major factor in improving system performance (Shabtay et al., 2010) (for more details see some surveys in Lauff and Werner (2004), Jozefowska (2007), Gordon et al. (2002), and Gordon et al. (2004a,b)). Henceforth, decision makers may need an efficient method for quoting due dates and job scheduling (Huynh Tuong and Soukhal, 2010). Of course, extending the due

* Corresponding author. Tel.: +98 3113912550; fax: +98 3113915526.
E-mail address: rasti@cc.iut.ac.ir (M. Rasti-Barzoki).

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