An Exact Method for the Periodic Inventory Routing Problem in a Lean Production System

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Abstract

We present a mixed-integer linear programming model to determine a periodic routing plan that supports the lean principles of level production planning and standardized work. We consider a lean production system consisting of a single manufacturing plant and a set of geographically-dispersed suppliers that supply a distinct product (component) to the plant. To facilitate level production planning, we require that the pickup amounts at each supplier are multiples of the daily demand and in exact proportion to the number of days since the last pickup. This results in an Inventory Clearing policy in which the inventory level of each supplier in every period is equal to zero after the pick-up. We seek to determine an inbound routing plan that collects component inventory from suppliers and delivers it to the plant at the minimum transportation and inventory holding cost. We present reformulations of the periodic IRP, under the Inventory Clearing policy, derived from the periodic single item Lot Sizing problem with Proportional Shipments. We define a generic family of valid inequalities, and then introduce delivery route inequalities for which the separation problem of generating violated inequalities can be solved effectively. A Branch-and-Cut algorithm is implemented to demonstrate the strength of the proposed reformulations.

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