Combined Production and Distribution Scheduling of Ready-Mix Concrete

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ABSTRACT

The need for combined production and distribution scheduling is paramount in Ready Mixed Concrete (RMC) production as having an inventory of the finished product to meet the fluctuating demand is just not possible. This research aims to develop a feasible operating schedule for RMC production by addressing (simultaneously) the mixing of raw materials at the plants and the delivery of final product (concrete) to customer sites.

As the concrete delivery capacity, determined by truck availability, basically defines the capacity to fulfill customer orders, focus in the research is placed on vehicle scheduling, and the production operations are included as part of the delivery activities. A model for scheduling vehicles in a multi-depot scenario with added time constraints is developed and solved by Branch-and-Cut Algorithm. Several algorithm-related techniques are evaluated and subsequently enhanced to further improve the solution quality. The adequacy of the solution methodology to solve the model is further verified by comparing with heuristics-based search techniques within a Constraint Programming framework. With real-life data drawn from operational profiles of local RMC companies, five sets of practical-size instances of the model are developed and solved.

Application of Branch-and-Cut, with Strong Branching and Best Estimate rules, is able to find good integer feasible solutions, even for the largest instances, given enough time. In terms of computational efficiency, however, the exact method does not perform as well as the heuristic search techniques, where a local search procedure is found to be the most efficient. We also explore the feasibility of the generated schedule and potential advantages of the modeling approach in this research.

Future extensions to this work would include model and algorithmic developments to address issues such as larger problem instances, order allocation to plants and emergencies (sudden orders, order changes, etc.) in real-time. Finally, the developed model can be applied, with suitable modifications, to industries with similar characteristics of highly perishable products and multiple Just-In-Time deliveries.

Keywords: supply-chain scheduling, delivery scheduling, heuristic search.

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