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# Multi-time Scale Procurement Planning Considering Multiple Suppliers and Uncertainty in Supply and Demand

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## Highlights

- A procurement system is studied by considering multiple supplier, and demand and supply uncertainty.
- The planning problem is formulated as a MDP, and integrated with a MILP scheduling model.
- An approximate framework based on the value function approximation is developed.
- A heuristic approximation of the scheduling is developed to reduce computational load.
- The proposed methodology is examined for benchmark case studies.

## Abstract

Inventory management of procurement system is decomposed into sub-problems according to the timescale of decisions: The long-term planning for ordering raw materials and the short-term scheduling for unloading the orders. To ensure more sustainable and robust operation, different decision layers should be integrated (which is nature of multi-scale), and supply and demand uncertainty should be considered. In this study, the planning problem is formulated as a Markov decision process (MDP) to incorporate possible realizations of uncertainty into the decision-making process. The MDP planning model is integrated with a scheduling model expressed by a MILP (or closely approximated by a heuristic approach). Decision policies are obtained from solving the MDP problem through an exact value iteration, as well as an approximate approach intended to alleviate the computational challenges. We compare the results from applying them with those of a reference policy obtained without any rigorous integration with scheduling through benchmark problems.

**Key words:** Procurement planning and scheduling, Multi-scale decision making, Supply and demand un-certainty, Markov decision process, Approximate dynamic programming

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