A collaborative Simulation-Optimization Framework for Supply Chain Network Design Considering the Bullwhip Effect

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Supply Chain Network Design (SCND) is a critical strategic decision in Supply Chain Management (SCM) that traditionally focuses on optimizing costs through mathematical models, such as the Inventory Location Problem (ILP). However, these models often overlook the significant impact of the Bullwhip Effect (BWE), a dynamic phenomenon that amplifies demand variability upstream in the supply chain, leading to inefficiencies. While ILPs tend to treat BWE as a static parameter, its magnitude is inherently dependent on the network configuration itself. This research addresses this gap by proposing an iterative simulation-optimization framework for SCND. Our approach combines an ILP model to define the network structure with a simulation model that dynamically evaluates the BWE for a given configuration. The BWE values obtained from the simulation are then fed back into the ILP model, allowing for a progressive refinement of the network design until a solution that explicitly considers BWE dynamics is achieved. This simulation-based approach offers a practical methodology for managers to design more robust and efficient SCND. Applied to instances from the literature, the proposed framework demonstrates its capability to generate insightful results and recommendations for both practitioners and researchers, outperforming previous static approaches by providing more realistic BWE values and improved network configurations.