OMICS Group Conferences
Accelerating Scientific Discovery

International Summit on
Industrial Engineering
December 08-10, 2014 DoubleTree by Hilton Hotel San Francisco Airport, USA

Tactical level supply chain planning with multi-echelon safety stock optimization

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Supply chain (SC) is a system with multi-layer entities, multi-layer processes, to convert raw material into products. There are three levels of planning issues in a supply chain, i.e., strategic, tactical, and operational levels. They differ from each other based on their considerations and time effects. The strategic level planning deals with issues in the design stage of a supply chain, tactical level considers utilizing the SC resources, and the operational level deals with daily or weekly scheduling issues. SC optimization and its responsiveness are greatly influenced by inventory and as such inventory and amount of safety stock are important issues in a supply chain to manage demand uncertainties and maintain customer service level at lowest possible cost and shortest responsive time. In this paper, the multi-echelon safety stock optimization (MESSO) for tactical supply chain planning (SCP) in manufacturing systems is addressed. The problem is formulated as a multi-objective mixed integer non-linear programming (MINLP) model. Unlike other works that consider serial, assembly, or distribution system only, our model considers general supply chain topology. In a competitive global market, different objectives should be optimized simultaneously to avoid conflicting decisions. In the SC planning context, two methods are often used to optimize multi-objective models. The first one is to convert the multi-objective problem into a single-objective using a weighted sum or weighted goal programming method. The main drawback of this method is the subjectivity and bias in weight setting. The other method is known as ε-constraint method in which one objective is optimized while the others are used as un-equality constraints. The same approach is applied to every objective leading to a set of solutions called Pareto optimal solutions or non-dominated points which form the Pareto-Optimal (Pareto-Efficient) Frontier. However, this method again involves subjectivity in determining which frontier point is selected eventually. For this reason, the modified Chebyshev programming (MFC) method is adopted to solve the multi-objective model. Unlike the conventional weighted sum method that subjectively assigns weight to each objective, the weights in the MCP method are automatically selected based on the importance order of the objectives, the model and input data. Application of the proposed model and solution method are illustrated by solving an example problem and compared with the traditional weighted-goal programming method.

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