

Closed-Loop Supply Chain: A Study of Bullwhip Effect Using Simulation

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Abstract : Closed-loop supply chain (CLSC) management focuses on integrating forward and reverse flow of material as well as information to maximize value creation over the entire life-cycle of a product. Bullwhip effect in supply chain management refers to the phenomenon where a small variation in customers' demand results in larger variation of orders at the upstream levels of supply chain. Since the quality and quantity of products returned to the collection centers (as a part of reverse logistics process) are uncertain, bullwhip effect is inevitable in CLSC. Therefore, in the present study, first, through an extensive literature survey, we identify all the important factors related to forward as well as reverse supply chain which causes bullwhip effect in CLSC. Second, we develop a system dynamics model to study the interrelationship among the factors and their effect on the performance of overall CLSC. Finally, the results of the simulation study suggest that demand forecasting, lead times, information sharing, inventory and work in progress adjustment rate, supply shortages, batch ordering, price variations, erratic human behavior, parameter correcting, delivery time delays, return rate of used products, manufacturing and remanufacturing capacity constraints are the important factors which have a significant influence on system's performance, specifically on bullwhip effect in a CLSC.

Keywords : bullwhip effect, closed-loop supply chain, system dynamics, variance ratio

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