Optimizing Two-player Supply Chain Performance: A System Dynamics Simulation Study
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EXECUTIVE SUMMARY

A two-player (Supplier-manufacturer) System Dynamics model is simulated to develop useful insights to formulate policy guidelines for supply chain (SC) performance. Balancing performance on multiple metrics is a challenge facing SC managers. While increasing safety stock levels could be the easiest fix to address unfilled orders situation in SCs, for obvious reasons, it’s counterproductive in improving inventory turns or minimizing related costs. Viable alternate options emerge with the help of optimization technique. Results from simulation of three types of customer order trends are presented. Given the dynamic complexity of SCs, the more we know the better we can manage them.

Keywords: Supply Chain Performance, Supply Chain Metrics, System Dynamics Modeling, Simulation, Optimization

INTRODUCTION

Supply chains are outwardly simple but dynamically complex business systems. As is well known, “A system is a collection of parts which interact with each other to function as a whole” (Kauffman, 1980). Complexity in a system could be of two types viz., detail complexity (too many variables) and dynamic complexity (Senge, 1991, pp 71-72; Sterman, 2000, pp. 21). Dynamic complexity typically refers to the behavior over time of key system variables. As is the case with many other complex business systems, supply chains consist of variables that interact with each other causing non linear behavior of system variables. System dynamics simulation modeling captures these non linear behaviors of system variables to provide useful insights / pointers for policy formulation. The more we know about these complex business systems the better we can manage them.

This study is part of a series of studies aimed at gaining a deeper and better understanding of supply chain dynamics using System Dynamics modeling methodology developed by Forrester (1958, 1961) and Sterman (2000). In our prior studies (Burns & Janamanchi, 2006; Janamanchi & Burns 2007a, 2007b, 2008) effects of reductions in information delays and flow delays as well as forecasting/smoothing upon supply chains with the intent of eliminating bullwhip effect and stabilizing production schedules have been explored. Lee at al. (1997) made an excellent contribution of understanding bullwhip effect in Supply chains. In our prior studies we sought to explain bullwhip using System Dynamics methodology. The focus of the current study is a two-player manufacturer- supplier supply chain with the intent of optimizing the performance of supply chain on desired supply chain metrics viz. minimizing “unfilled orders” as well as “inventory related costs” under different customer order pattern scenarios.

The remainder of this paper is organized as follows. Section 2 briefly describes the modeling tool and explains the general outline of a hypothetical supplier–manufacturer supply chain set up. Presented in section 3 are the results from the simulation of the base case and three trends of customer order patterns and Optimization results under three different objective functions. These results are followed by discussion of insights that may be gained from these results. Finally, section 4 lists the contributions/limitations of the current study and directions for possible future studies.