Chapter 18

Supply Chain Management via System Dynamics in Flexible Manufacturing System

Arzu Eren Şenaras
https://orcid.org/0000-0002-3862-4551
Bursa Uludag University, Turkey

Onur Mesut Şenaras
Bursa Uludag University, Turkey

ABSTRACT

System dynamics is a method that allows analysts to separate complex social, and behavioral systems into components, to visualize them by reconstructing them as a whole again, and to develop a simulation model. In this chapter, a system dynamics model is developed for a flexible manufacturing system. The case study is developed using Vensim package program. To manage a flexible manufacturing system it is important to determine production schedule rules and examine results. System dynamics is a tool to test these rules without any production loss.

INTRODUCTION

System dynamics approach was developed by Jay Forrester from MIT during the 1950’s to analyze especially the complex behavior in administration with computer simulation in the social sciences. System dynamics is a form of the systems approach as a methodology to understand the dynamic behavior of complex systems. The basis of system dynamics is to understand how system structures cause system behavior and system events (Sezen, 2009, p. 298).

Jay Forrester initially constructed his first dynamic model during his meeting with the management of General Electric Corporation. Big fluctuations in production, inventory, labor force and profitability were compelling GE management. Despite the hard efforts of the management, these fluctuations were mostly associated with external factors. Especially, the fluctuations in the business were related to received
orders. Forrester interacted with the management to observe the system operations in other departments. In the first model he developed, he observed that simulations were necessary since the system could not be monitored analytically. He demonstrated that the corporation could experience serious fluctuations due to management policies even when the demand is considered constant with the weekly simulation he ran. Later on, he designed the computer simulation for the same problem. In his later studies, Forrester demonstrated how the feedback control theory could be adapted for complex administration and human systems. He published his initial findings in an article in Harvard Business Review. Later on, he developed this study to write his famous work “Industrial Dynamics” (Lane and Sterman, 2011; Ramage and Shipp, 2009, pp. 100-101).

**SHORT LITERATURE REVIEW**

Olhager and Selldin (2004) investigated supply chain management strategies and practices in a sample of 128 Swedish manufacturing firms. They specifically studied issues related to the supply chain design, integration, planning and control, and communication tools for managing supply chains. The main findings indicate the following. The extent to which suppliers and customers are involved in supply chain planning and control is expected to increase steadily over the next 2 years.

Kehoe and Boughton (2001) studied to describe current research which examines the classification of manufacturing supply chains and positions Internet-based applications in order to identify the operations management challenges for the next generation of manufacturing planning and control systems.

Lee and Kim (2007) studied a review of the development and use of multi-agent modelling techniques and simulations in the context of manufacturing systems and supply chain management (SCM). The objective of the paper is twofold. First, it presents a comprehensive literature review of current multi-agent systems (MAS) research applications in the field of manufacturing systems and SCM. Second, it aims to identify and evaluate some key issues involved in using MAS methods to model and simulate manufacturing systems.

Ghadge et.al. (2018), studied to assess the impact of additive manufacturing (AM) implementation on aircraft supply chain (SC) networks. Additive and conventional manufacturing spare part inventory control systems are studied and compared, revealing insights into SC performance. The paper offers guidance on the adaption of AM in aircraft SCs and AM’s impact on spare part inventory systems. The study provides robust evidence for making critical managerial decisions on SC re-design driven by a new and disruptive technology. Next-generation SC and logistics will replace the current demand for fulfilling material products by AM machines.

Mönch et al. (2018) proposed a classification scheme for the relevant literature. The remainder of this paper then focuses on Strategic Network Design models for this industry, supply chain coordination through contracting and semiconductor supply chain simulation. Part II discusses Demand Planning, Inventory Management and Capacity Planning, while Part III addresses Master Planning, Production Planning and Demand Fulfilment. They presented an overview of the semiconductor supply chain from a decision-making and functional perspective to provide a foundation for a review of the industrial engineering and operations research literature addressing supply chain problems in this industry. They then reviewed the literature on strategic supply chain network design, the use of contracting mechanisms to coordinate the different agents in a supply chain, the very recently emerging literature on sustainability issues in these supply chains, and semiconductor supply chain simulation.