Chapter 87
Application of Dynamic Analysis in a Centralised Supply Chain

Mu Niu
Northumbria University, UK

Petia Sice
Northumbria University, UK

Ian French
University of Teesside, UK

Erik Mosekilde
The Technical University of Denmark, Denmark

ABSTRACT

This chapter presents dynamic analysis of a model of a centralised supply chain. The research was conducted within the manufacturing sector and involved the breathing equipment manufacturer Draeger Safety, UK A simplified model of the Draeger Safety, UK centralised supply chain is developed and validated. Simulation and analysis are performed using System Dynamics, control theory, nonlinear dynamic and chaos theory. The findings suggest that destructive oscillations of inventory could be generated by internal decision making practices. Bifurcation diagram is plotted to indicate the bifurcation status of the model with different internal decision policies. A management microworlds is developed for managers to experiment with different decision scenarios and learn how the supply chain performs.

INTRODUCTION

The contemporary business environment is characterised by an acceleration of the process of change due in part to improved communication and analytical capabilities brought about by modern Information and Communication Tech-nologies (Sterman, 2000; Terzi and Cavalieri, 2004; Ortega and Lin, 2004). This poses an ever increasing demand for periodical review of strategies and organisational processes, and for faster and more effective learning to deal with problem situations more quickly. Furthermore, companies increasingly need to react to customer requirements (Hong-Minh, Disney and Naim, 2000). Naylor et al (1999) suggested the principles of

agile manufacturing, i.e. responding to customer requirements with very short lead-times can be applied to supply-chains. Global companies are realising that the efficiency of their businesses is dependent on the collaboration with their suppliers and customers (van der Zee, 2005; Yusuf, Gunasekaran, 2004; Adeleye and Sivayoganatahn, 2004; Cox et al, 2004). The concept *of supply chain management* (SCM) is concerned with the strategic approach of integrating producers, suppliers and customers in a collaborative network with the objective of improving the overall responsiveness of the network, but at the same time preserving the organisational autonomy of each unit (Terzi and Cavalieri, 2004). More accurate data and better information available to all nodes of the supply chain are considered crucial in improving its performance. Thus, companies invest heavily in intra-company information and communication platforms and E-collaboration tools, such as data warehouses or Enterprise Resource Planning (ERP) and Manufacturing Resource Planning systems (Lyneis, 2005; Li & Li, 2005; Marquez, Bianchi and Gupta, 2004).

Contemporary Manufacturing Resource Planning (MRP) is a structured approach to manufacturing management in which a suite of integrated computer software covering the main operational business functions is used to assist the planning of materials, capacity and cash flow, in accordance with company policy, to meet customer delivery requirements (Ackermans & Dellaert, 2005). It is a total approach to managing a business (Li & Li, 2005). It includes inventory control data, purchasing and accounts payable, suppliers' data, master schedules, production schedules, resource capacities, manufacturing orders, and so on. MRP systems are developed under the assumption that more data and better information lead to better decisions. The quality of this data is believed to be accurate or at least good enough to be reliable (Ackermans and Dellaert, 2005). However, even with the introduction of resource planning systems, the performance of the supply chain often remains problematic (Lyneis, 2005; Fowler, 1999). The weakness of such systems is that when used on their own they fail to address the complexity of management situations for two reasons: firstly, they do not take into account the inherent 'messiness' of situations that contain human decision making within the process that is considered problematic (Maturana & Varela, 1987; Beer, 1979, 1994); secondly, such tools do not promote learning (Senge, 1984, 1996; Venix, 1994; Morecroft, 2007) or effective decision support as they do not include simulation facilities to allow what-if analysis on alternative strategies (Terzi and Cavalieri, 2004).

After reviewing more than eighty scientific papers on the role and application of simulation in the supply chain, Terzi and Cavalieri (2004) show how simulation is successfully adopted in different studies of logistic networks. Their findings ascertain that simulation allows evaluation of performance prior to the implementation of the system since: 1) it enables companies to perform powerful what-if analyses leading to learning and improved planning decisions; 2) permits the comparison of alternative strategies in a safe virtual world, without interrupting the real system; 3) permits time compression that allows for timely policy decisions to be made. These findings are also supported by Chang and Makatsoris (2001).

The suitability of simulation as an approach to studying supply chains does not guarantee its adequate decision support (van der Zee, 2005) as simulation relies on a heuristic search for good decisions strategies led by people. The success of the simulation study depends on the joint work of the analyst and the chain managers and actors, as well as the facilities offered by the modelling and simulation tools. Van der Zee (2005), Sterman (2000) and Senge (1996) suggest that it is important to consider the simulation model as a communicative tool between analysts and chain actors. System Dynamics (Forrester, 1961; Sterman 2000) as a modelling and simulation framework has been developed for such a purpose.

Related Content

Alternative Approaches to Auction Trading by Consortia in Multi Agent Systems: A Comparative Study

Barin N. Nag, Dong-Qing Yaoand Sungchul Hong (2013). *Production and Manufacturing System Management: Coordination Approaches and Multi-Site Planning (pp. 1-14).*

www.irma-international.org/chapter/alternative-approaches-auction-trading-consortia/70047

Multiple Criteria DEA-Based Ranking Approach With the Transformation of Decision-Making Units

Jae-Dong Hong (2021). *International Journal of Applied Industrial Engineering (pp. 1-20).*

www.irma-international.org/article/multiple-criteria-dea-based-ranking-approach-with-the-transformation-of-decision-making-units/276088

Application of Multiple Regression and Artificial Neural Networks as Tools for Estimating Duration and Life Cycle Cost of Projects

Brian J. Galli (2020). *International Journal of Applied Industrial Engineering (pp. 1-27).*

www.irma-international.org/article/application-of-multiple-regression-and-artificial-neural-networks-as-tools-for-estimating-duration-and-life-cycle-cost-of-projects/263793

Improving Industrial Product Lifecycle Management by Semantic Data Federations

Steffen Kunz, Benjamin Fabian, Markus Aleksy, Matthias Wauerand Daniel Schuster (2012). *Handbook of Research on Industrial Informatics and Manufacturing Intelligence: Innovations and Solutions (pp. 415-439).*

www.irma-international.org/chapter/improving-industrial-product-lifecycle-management/64731

Critical Evaluation of Continuous Improvement and Its Implementation in SMEs

Pritesh Ratilal Pateland Darshak A. Desai (2020). *International Journal of Applied Industrial Engineering (pp. 28-51).*

www.irma-international.org/article/critical-evaluation-of-continuous-improvement-and-its-implementation-in-smes/263794