공급사슬경영의 연구 동향 및 향후 연구 과제

김숙한, 이영해

Current and Future Directions for Researches on Supply Chain Management

Sook Han Kim, Young Hae Lee

한양대학교 산업공학과

Abstract

As the industrial environment becomes more competitive, supply chain management (SCM) has become recognized as a major strategy in the business world. Some of current researches are categorized into review papers, deterministic models, stochastic models, simulation models and discussed in this paper. A hybrid approach combining analytic model and simulation model and the simulation optimization method are proposed as future research areas with other analytical subjects.

1. Introduction

SCM is the management of material and information flows both in and between facilities, such as vendors, manufacturing and assembly plants and distribution centers. To implement SCM in the real logistic world, various types of models have been developed. These models could be divided into two major categories; analytic models and simulation models, which have both their own advantages and disadvantages.

Some of current researches are categorized into four parts; review papers, deterministic models, stochastic models, simulation models and introduced on the basis of their purposes and approaches and also further research areas are discussed in this paper.

2. Review papers

For years, researchers and practitioners have primarily studied the various processes of the supply chain individually. Several authors investigate and analyze researches on SCM and provide their comments and further research areas.

Simpson et al. [1] propose a taxonomical framework for analyzing supply chains from an operational perspective.

Beamon [2] provides a focused review of literature in multi-stage chain modeling and define a research agenda for future research.

Vidal and Goetschalckx [3] review and categorize the literature that addresses the comprehensive strategic production-distribution models, with emphasis on mixed integer programming models.

Thomas and Griffin [4] offer a review of research on coordinated SCM.

Maloni and Benton [5] provide a review of supply chain research from both the qualitative conceptual and analytical operations research perspectives.

3. Analytic Models

An analytic model is a set of equations that characterize a system or a problem entity. Its solution procedure usually uses either an analytical equation or a numerical algorithm that has been developed for the set of model equations to obtain the desired results. Analytic models are divided into deterministic models, in which the variables are known and specified, stochastic analytic models, where at least one of the variables is unknown, and is assumed to follow a particular probability distribution [6].

3.1 Deterministic models

Williams [7] presents heuristic algorithms for scheduling production and distribution operations in an assembly supply chain network.

Ishii et al. [8] develop a deterministic model for determining the base stock levels, and lead times associated with the lowest cost solution for an integrated supply chain on a finite time horizon.

Cohen and Lee [9] present a deterministic, mixed integer, non-linear mathematical programming model, based on economic order quantity (EOQ) techniques, to develop what the authors refer to as a global resource

deployment policy.

Cohen and Moon [10] extend Cohen and Lee [9] by developing a constrained optimization model, called PILOT, to investigate the effects of various parameters on supply chain cost.

Arntzen et al. [11] introduces the most comprehensive deterministic model for SCM: the Global Supply Chain Model (GSCM).

Voudouris [12] develops a mathematical model designed to improve efficiency and responsiveness in a supply chain.

Camm et al. [13] develop an integer-programming model, based on an uncapacitated facility location formulation.

Uzsoy and Venkatachalam [14] present a linear programming model of a multistage supply chain with product recovery and remanufacturing capability.

Li and OBrien [15] focus on improving supply chain efficiency and effectiveness under four criteria, profit, lead time performance, delivery promptness and waste elimination, instead of the cost alone.

Kelle and Milne [16] examine the effect of (s, S) ordering policy on the order variability in a supply chain and provide quantitative tools for the estimation of the variability increase.

Ganeshan [17] presents a near-optimal (s, Q) type inventory policy for a production/distribution network with multiple suppliers replenishing a central warehouse.

3.2 Stochastic analytical models

Cohen and Lee [18] develop a model for establishing a material requirements policy for all materials for every stage in the supply chain production system.

Svoronos and Zipkin [19] consider multi-echelon, distribution-type supply chain systems.

Lee and Billington [20] develop a heuristic stochastic model for managing material flows on a site-by-site basis.

Lee et al. [21] develop a stochastic, periodic-review, order-up-to inventory model to develop a procedure for process localization in the supply chain.

Pyke and Cohen [22] develop a mathematical programming model for an integrated supply chain, using stochastic sub-models to calculate the values of the included random variables contained in the mathematical program.

Tzafestas and Kapsiotis [23] utilize a mathematical programming approach to optimize a supply chain, then use simulation techniques to analyze a numerical example of their optimization model.

Lee et al. [24] develop stochastic mathematical models describing the bullwhip effect.

Van der Laan and Salomaon [25] consider a stochastic inventory system with production, remanufacturing, and disposal operations.

Escudero et al. [26] present a modeling framework for the optimization of a manufacturing, assembly and distribution (MAD) supply chain planning problem.

4. Simulation models

A simulation model is a dynamic or an operating model of a system or problem entity that resembles the operating behavior of the system or problem entity and contains its functional relationships.

Wikner et al. [27] examine five supply chain improvement strategies, then implement these strategies on a three-stage reference supply chain model.

Towill [28] uses simulation techniques to evaluate the effects of various supply chain strategies on demand amplification.

Petrovic et al. [29] describe fuzzy modeling and simulation of a supply chain in an uncertain environment, as the first step in developing a decision support system.

Ingalls [30] discusses the reasons why one would want to use simulation as the analysis methodology to evaluate supply chain.

Umeda and Jones [31] propose an integration test-bed system for supply chain management, which forms the foundation for the construction of a value manufacturing chain.

Zhang et al. [32] discuss the issue of SCM and the development of supply chain simulator.

Hieta [33] describes how supply chain simulation has been used in Nokia Research Center.

Bagchi et al. [34] introduce the IBM supply chain simulator (SCS) which is a software tool that can help a company of a group of companies make strategic business decisions about the design and operation of its supply chain.

Jain et al. [35] report on a study to compare the quality of results at different levels of details in a semiconductor supply chain simulation.

Simulation and optimization modeling techniques are used to help make supply chain strategic decisions by Hicks [36].

5. Further Researches

SCM has generated many research efforts in recent years and will continue to be an

important area of research for many years. Based on our review there are several future research directions.

Optimization tech. such as linear or mixed integer programming is useful for solving well-defined mathematical problems. But these problems are rigidly defined and usually have simplifying assumptions in their formulations. However, real world is quite different from these assumptions. Simulation provides a method of analysis that is applicable when mathematical analysis is to hard, and it allows the analyst to model a real system in a way that is more complicated than mathematical analysis would permit. One of the more interesting areas of research, that has received increasing attention in recent years, is the optimization of simulation models that encompass multiple input variables and multiple responses. Using simulation optimization tech. in modeling SCM is a future research area

Available research has not specifically addressed the adequacy or appropriateness of existing supply chain performance measures. The establishment of appropriate performance measures is an important research area.

Analytical and simulation models that integrate the three major stages of supply chains: supplier, production, distribution is also an important future direction of research. Integrated approaches to managing inventory decisions at all stages of the supply chain need to be developed.

Solving the problem with limited capacity supply chain management will continue to be an important area of research for many years. is also a future research agenda. As one of major constraints in this planning problem in SCM, capacities has mostly been known. But in the real systems significant difference exits between capacity and the required time to achieve the production and distribution plan. Therefore, the machine capacity and distribution capacity constraints in modeling should be considered as dynamic factors.

6. Conclusions

SCM is a core competitive strategy in modern business and logistic area. A great deal of literature has attempted to research on SCM. We divide current researches into four categories: review papers, deterministic models, stochastic models, simulation models and discuss them in detail. We propose further research areas: (1) the simulation optimization method, which reflects the system dynamics and multi-input variables of SCM in modeling SCM, (2) the establishment of appropriate performance measures, which are used to determine the efficiency and/or effectiveness of an existing system, or to compare competing alternative systems, (3) integrated approaches managing all stages of the supply chain concurrently in the real situation, (4) designing and solving the problem of supply chain planning problems with limited capacity.

The expanding importance of SCM presents a challenge to operations researchers to focus more attention on its modeling and solution procedures.

References

[1] Simpson, N.C., Erengnc, .S., Vakharia, A.J. "Integrated production/distribution planning in supply chains: an invited review," *European Journal of Operational Research,* Vol 115(1999), pp.219-236

[2] Beamon, B.M., "Supply Chain design and analysis : Models and m ethods ," *International Journal of Production Economics,* Vol 55(1998), pp.281-294

[3] Vidal, C.J., Goetschalckx M., "Strategic production-distribution models : a critical review with emphasis on global supply chain models," *European Journal of Operational Research,* Vol 98(1997), pp.1-18

[4] Thomas, Griffin, "Coordinated Supply Chain Management," *European Journal of Operational Research,* Vol 94(1996), pp.1-15

[5] Maloni, M. J., Benton,W.C., "Supply chain partnerships: opportunities for operations research," *European Journal of Operational Research,* Vol 101(1997), pp.419-429

[6] Shanthikumar, J.G., Sargent, R.G., "A unifying view of hybrid simulaiton/analytic models and modeling," *Operations Research,* Vol 31 No 6(1983), pp.1030-1052

[7] Williams, J.F., "Heuristic techniques for simultaneous scheduling of production and distribution in multi-echelon structures: Theory and empirical comparisons," *Management Science,* Vol 27 No 3(1981), pp.336-352

[8] Ishii, K., Takahashi, K., Muramatsu, R., "Integrated production, inventory and distribution systems," *International Journal of Production Research,* Vol 26 No 3(1988), pp.473-482

[9] Cohen, M.A., Lee, H.L., "Resource deployment analysis of global manufacturing and distribution networks," *Journal of Manufacturing and Operations Management,* Vol 2(1989), pp.81-104

[10] Cohen, M.A., Moon, S., "Impact of production scale economies, manufacturing complexity, and transportation costs on

supply chain facility network," *Journal of Manufacturing and Operations Management,* Vol 3(1990), pp.269-292
[11] Arntzen, Brown, Harrison, Trafton, "Global Supply Chain Management at Digital Equipment Corporation," *Interfaces,* Vol 25(1995), pp.69-93
[12] Voudouris, V.T., "Mathematical programming techniques to debottleneck the supply chain of fine chemical industries," *Computers and Chemical Engineering,* Vol 20(1996), pp.1269-1274
[13] Camm, J.D., Chorman, T.E., Dull, F.A., "Blending OR/MS, judgement, and GIS: Restructuring P&Gs supply chain," *Interfaces,* Vol 27 No 1(1997), pp.128-142
[14] Uzsoy, Venkatachalam, "Supply chain management for companies with product recovery and remanufacturing capability," *research memorandum,* No.97-2(1997)
[15] Li, D., OBrien, C., "Integrated decision modeling of supply chain efficiency," *International Journal of Production Economics,* Vol. 59(1999), pp.147-157
[16] Kell, P., Milne, A., "The effect of (s, S) ordering policy on the supply chain," *International Journal of Production Economics,* Vol 59(1999), pp.113-122
[17] Ganeshan, R., "Managing supply chain inventories: a multiple retailer, one warehouse, multiple supplier model," *International Journal of Production Economics,* Vol 59(1999), pp.341-354
[18] Cohen, M.A., Lee, H.L., "Strategic analysis of integrated production-distribution systems: Models and methods," *Operations Research,* Vol 36 No 2(1988), pp.216-228
[19] Svoronos, A, Zipkin, P., "Evaluation of one-for-one replenishment policies for multiechelon inventory systems," *Management Science,* Vol 37 No 1(1991), pp.68-83
[20] Lee, H.L., Billington, C., "Material management in decentralized supply chains," *Operations Research,* Vol 41 No 5(1993), pp.835-847
[21] Lee, H.L., Billington, C., "Carter, B. Hewlett-Packard gains control of inventory and service through design for localization," *Interfaces,* Vol 23 No 4(1993), pp.1-11
[22] Pyke, D.F., Cohen, M.A., "Performance characteristics of stochastic integrated production-distribution systems," *European Journal of Operational Research,* Vol 68 No 1(1993), pp.23-48
[23] Tzafestas, S., Kapsiotis, G., "Coordinated control of manufacturing /supply chains using multi-level techniques," *Computer Integrated Manufacturing Systems,* Vol 7 No 3(1994), pp.206-212
[24] Lee, H.L., Padmanabhan, V., Whang, S., "Information distortior: in a suppy chain: The bullwhip effect," *Management Science,* Vol 43 No 4(1997), pp.546-558
[25] Van der Laan, Salomon, "Production planning and inventory control with remanufacturing and disposal," *European Journal of Operational Research,* Vol 102(1997), pp.264-278
[26] Escudero, L.F., Galindo, E., Garcia, G., Gomez, E., Sabau, V., Schumann, "A modeling framework for supply chain management under uncertainty," *European Journal of Operational Research,* Vol 119(1999), pp.14-34
[27] Wikner, J., Towill, D.R., Naim. M., "Smoothing supply chain dynamics," *International Journal of Production Economics,* Vol 22 No 3(1991), pp.231-248
[28] Towill, D.R., "Supply chain dynamics," *International Journal of Computer Integrated Manufacturing,* Vol 4 No 4(1991), pp.197-208
[29] Petrovic, D., Roy, R., "Modeling and simulation of a supply chain in an uncertain environment," *European Journal of Operational Research,* Vol 109, No2(1998), pp.299-309
[30] Ingalls, "The value of simulation in modeling supply chains," *Proceedings of 1998 Winter Simulation Conference,* pp.1371-1375(1998)
[31] Umeda, Jones, "An integration test-bed system for supply chain management," *Proceedings of 1998 Winter Simulation Conference,* pp.1377-1385, 1998(1998)
[32] Zhang, Hunt, Browne, "The development of an extended enterprise supply chain management simulator," http // cimru.ucg.ie / projects / logsme / LogInfo / LogDis / papers / devsim.html, (1999)
[33] Hieta, "Supply chain simulation with logsim-simulator," *Proceedings of 1998 Winter Simulation Conference,* pp.323-326(1998)
[34] Bagchi, Buckley, Ettl, Lin, "Experience using the IBM supply chain simulator," *Proceedings of 1998 Winter Simulation Conference,* pp.1387-1394(1998)
[35] Jain, S., Lim, C., Gan, B., Low, Y., "Criticality of detailed modeling in semiconductor supply chain simulation," *Proceedings of the 1999 Winter Simulation Conference,* pp.888-896(1999)
[36] Hicks, D. A., "A four step methodology for using simulation and optimization technologies in strategic supply chain planning," *Proceedings of the 1999 Winter Simulation Conference,* pp.1215-1220(1999)