IDEA GROUP PUBLISHING

701 E. Chocolate Avenue, Suite 200, Hershey PA 17033, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com

ITP4712

Developing and Optimizing Distribution Model of Electronic Supply Chain Management System in Indian Context

Satyendra Kumar
Doctoral Student, Indian Institute of Management, Ahmedabad, India
FPM House - 14, IIMA Campus, Vastrapur, Ahmedabad, India - 380015
+91-79-6324121 (O), 6327914(R), 6306896 (Fax)
satya@iimahd.ernet.in

ABSTRACT

The proposed study will develop a framework to assess the electronic supply chain management model based on the existing literature and the impact of information technology (IT) and electronic commerce (EC) on supply chain management (SCM). The framework will result in recognizing the structure, operations, and performance indicators of electronic supply chain in Indian context and optimizing the various variables considered. It will provide an interdisciplinary view of electronic commerce and supply chain modeling.

1. INTRODUCTION

Firms are facing intense competition in today's global business environment. They have to produce quality products at competitive prices with uncertain demand. To be competitive, a firm has to quickly respond to demand fluctuations, competition, and new market opportunities. Lagging the competition even slightly can be a threat to the viability of the business. In addition, businesses need to be increasingly customer-driven and more efficient both in the operations and in interaction with suppliers and partners. All these require a very efficient supply chain management.

1.1 Impact of IT and EC on SCM

Information technology is a critical enabler of effective supply chain management. Indeed, much of the current interest in supply chain management is motivated by the opportunities that appeared due to abundance of data and the savings that can be achieved by sophisticated analysis. Moreover, Internet is emerging as the most efficient way of sharing information between the globally dispersed partners and allowing them to address international markets. This has changed the nature of competition and firms' are forced to adopt electronic commerce.

Electronic Commerce is transforming the marketplace by changing firms' business model, by transforming relations among market actors, and by contributing to changes in market structure. It provides the opportunities for economic growth created by organizational change. It also creates the possibility of new models for organizing production and transacting business, by offering complementary products / services in business models.

One of the major effects of electronic commerce on supply chain management system is the emergence of Internet enabled distribution channel. The two of the most prominent sales channel on the Internet are *direct sales via Company Web sites* and *sales via Electronic Marketplaces* [Keskinocak and Tayur, 2001]. These distribution channels may require a different supply chain structure (number of echelon levels, location of warehouses, etc.) and policy (inventory and transportation policy).

1.2 Context

Firms are investing in electronic supply chain systems as it can create value at two levels: *increased visibility across the supply chain, and online sharing of information and collaboration between supply chain partners*. The online information sharing between the supply partners includes information related to orders, stock position, transportation details, etc. Theoretically, the electronic supply chain will lead to operate the functions of supply chain in more efficient and cost effective manner. The broader issue the firms are facing is how they can extract the benefits of electronic supply chain, what should be their supply chain structure, which operations they should automate, etc.

2. LITERATURE REVIEW

The theoretical foundation of the proposed study will be based on supply chain optimization, impact of information technology and information sharing on supply chain management, and Internet enabled distribution channel.

2.1 Supply Chain Optimization

The two major elements of supply chain optimization i.e. inventory and distribution models have attracted much attention from academics and practitioners.

At the discrete level, inventory model is designed to address two fundamental issues: when to replenish and how much be the order quantity, whereas a distribution model is designed to minimize the cost of distributing products located at a central facility to geographically dispersed facilities with different objectives to meet such as, minimization of variable distribution cost, optimization of fleet size, and minimization of delivery time. Much of the interest now lies in integrated distribution-inventory models.

One of the first papers that consider an integrated distribution-inventory has been done by Burns et al. (1985). They derived formulas for transportation and inventory costs, and determined the trade-off between these costs. Further, they analyzed and compared the two distribution strategies; direct shipping and peddling. Anily and Federgruen (1990) discussed a similar problem with a depot and many dispersed retailers to determine feasible replenishment strategies to minimize long run average transportation and inventory costs.

2.2 Information flow in Supply Chain

One of the important components of SCM is to manage the information flow between the partners in multi-stage production-distribution networks. Identifying and managing information requirements in the supply chain for decision-making process are becoming critical. Many authors have even argued that information flow within the chain can be a substitute to the inventory. Chen (1999) have shown that the information lead-time plays the similar role as the production / transportation lead-time in the determination of the optimal replenishment strategies; information lead-time being less costly.

Lee and Whang (2000) have discussed various types of information to be shared as inventory, sales, demand forecast, order status, and production schedule. Cachon and Fisher (2000) studied the value of sharing demand and inventory data. Chen et al. (2000) quantified the bullwhip effect and Lee et al. (2000) quantified the information sharing in a supply chain.

2.3 Information Technology and Supply Chain

Geoffrion and Krishnan (2001) discussed the prospects of Operations Research (OR) in the Electronic Commerce era. In a similar context, Sodhi (2001) provides a detailed example showing the use of Electronic Resource Planning (ERP) and Advanced Planning and Scheduling (APS) in a Web-enabled supply-chain environment for an electronics company.

2.4 Internet enabled distribution channel

Firms can have multiple benefits using the Internet as a distribution channel. The benefits include lower transactional cost, improved service level, ability to cater customer's preferences, etc. [Keskinocak and Tayur, 2001]. The Internet can provide value from increased visibility and collaboration among the supply chain partners, which refers to the ability to use the common information base. Because of its characteristics and foreseen benefits, Internet can be considered as a global virtual market distribution channel [Rahman and Raisinghani, 2000].

3. RESEARCH QUESTIONS

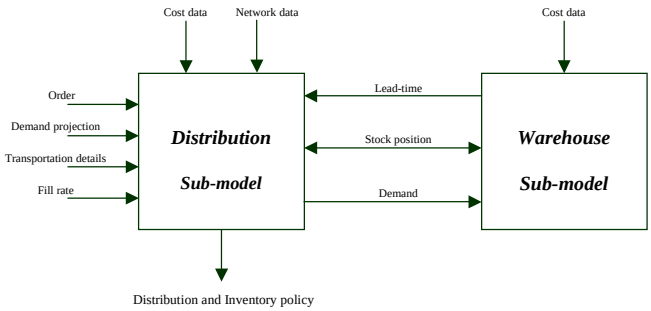
The research objective is *"to develop and optimize the distribution model of electronic supply chain in Indian context"*. The proposed study will be addressing following research questions:

- *How the distribution model of electronic supply chain is different from the traditional supply chain in terms of structure, lead-time, inventory policy, cost elements, pricing structure, etc.?*
- *How the distribution model of electronic supply chain can be optimized?*

4. RESEARCH METHODOLOGY

The proposed research will be an exploratory study to develop and optimize the distribution model of electronic supply chain in Indian context. The research will be using multiple methodologies to answer the research questions.

4.1 Conceptual Model



4.2 Research Approach

The broad approach of this research is appended in the following steps:

- We have first assessed the supply chain theories and models in the context of electronic commerce era. One of the comprehensive supply chain models was discussed by Cohen and Lee (1988). Since, our study is limited to distribution model; we focused only on *Warehouse & Distribution Sub-models* from the above-mentioned comprehensive model. We further introduced the relevant variables based on *Electronic Supply Chain* context and thus formulated the conceptual model (Refer-Figure 1)
- The conceptual model, formulated from theoretical inputs, requires a thorough verification for completeness of all the variables in the conceptual model. For this we adopted the case methodology approach. We have done comprehensive case studies with the three manufacturing organizations, which has implemented Web application for doing business, and studied their supply chain operations related to distribution. The profile of the studied organizations varies from *Industrial Product* to *Fast Moving Consumer Goods* with varied supply chain structure and operations. This has captured the issues involved in the distribution of electronic supply chain in Indian context.
- The case studies with the organizations verified the variables considered in the conceptual model and provided the cost elements. We are in a process to formulate and optimize the generic model of the electronic supply chain for the specific industry taking the issues and cost elements from the case-studies. The model will address the worthiness of performing different operations through online computer applications. For example: the FMCG firm is dealing with a single inventory product. The majority of the plant production is consumed in a nearby metropolitan city. Now, through modeling approach (Refer-Appendix A) we will try to find out whether the online stock information at these retail outlets will be beneficial for the company. The approach will be to find out the total expected contribution with and without perfect stock information. The difference between the two cases and the total cost for the online information sharing and processing will allow deciding whether the online information sharing will help the firm.

5. SIGNIFICANCE OF THE STUDY

The aim of the study is to address the issues involved in the distribution model of electronic supply chain in Indian context, where currently limited knowledge exists. This study will address some current questions facing the Indian organizations to efficiently manage their logistics in electronic commerce era. It will result in recognizing the structure and operations of electronic supply chain and a framework for optimizing the various variables considered. It will provide an interdisciplinary view of electronic commerce and supply chain modeling.

REFERENCES

Anily, S., and Federgruen A. "One warehouse multiple retailer systems with vehicle routing costs", *Management Science*, Vol. 36, No. 1, January 1990, pp. 92-114.

Burns, L. D., Hall R. W., Blumenfeld, D. E., and Daganzo C. F. "Distribution strategies that minimizes transportation and inventory costs", *Operations Research*, Vol. 33, 1985, pp. 469-490.

Cachon, G. P., and Fisher M. "Supply Chain Inventory Management and the Value of Shared Information", *Management Science*, Vol. 46, No. 8, August 2000, pp. 1032-1048.

Chen, F. "Decentralized Supply Chains Subject to Information Delays", *Management Science*, Vol. 45, No. 8, Aug. 1999, pp. 1076-1090.

Chen, F., Drezner Z., Ryan J. K., and Simchi-Levi D. "Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead-times, and Information", *Management Science*, Vol. 46, No. 3, March 2000, pp. 436-443.

Cohen, M. A., and Lee H. L. "Strategic analysis of integrated production-distribution systems: Models and methods", *Operations Research*, Vol. 36, No. 2, Mar-Apr 1988, pp. 216-228.

Geoffrion, A. M., and Krishnan R. "Prospects for Operations Research in the E-Business Era", *Interfaces*, Vol. 31, No. 2, Mar-Apr 2001, pp. 6-36.

Keskinocak, P., and Tayur S. "Quantitative Analysis for Internet-Enabled Supply Chains", *Interfaces*, Vol. 31, No. 2, Mar-Apr 2001, pp. 70-89.

Lee, H. L., So K. C., and Tang C. S. "The value of Information sharing in a two-level supply chain", *Management Science*, Vol. 46, No. 5, May 2000, pp. 626-643.

Lee, H. L., and Whang S. "Information sharing in a supply chain", *International Journal of Technology Management*, Vol. 20, Nos. 3/4, 2000, pp. 373-387.

Rahman, S. M., and Raisinghani M. S. "Electronic commerce: Opportunity and Challenges", *Idea Group Publishing*, 2000.

Sodhi, M. S. "Applications and Opportunities for Operations Research in Internet-Enabled Supply Chains and Electronic Marketplaces", *Interfaces*, Vol. 31, No. 2, Mar-Apr 2001, pp. 56-69.

APPENDIX - A

Model Formulation

Sets

- r: Retailer
- p: Product

- v: Vehicle

Parameters

- X_{rp}: Quantity of product 'p' demanded at retail outlet 'r' (litres)
- $F_{rp}(X)$: The probability density-function of demand at retail outlet 'r' for product 'p'.
- US_p: Understocking cost of product 'p' (Rs. per litre)
- OS_p: Overstocking cost of product 'p' (Rs. per litre)
- N: Number of vehicles in the transportation system (number)
- VL: Vehicle capacity load (crates)
- Cap_r: Storage capacity at retail outlet 'r' (crates)
- Sup_p: Available supply of product 'p' (crates)
- Stk_{rp}: Stock of product 'p' available at retail outlet 'r' (litres)
- Qty_{rp}: Total quantity of product 'p' available at retail outlet 'r' for meeting the demand (litres)

Variables

- Q_{vrp}: Quantity of product 'p' to be delivered at retail outlet 'r' by vehicle 'v' (crates)
- Y_v: Is 1 if the vehicle 'v' is used for delivery purposes, otherwise 0 (binary decision variable)
- D_{rv}: Is 1 if the vehicle 'v' is used to deliver at retail outlet 'r', otherwise 0 (binary decision variable)

Note:

- A crate is a plastic container, which can hold 10 litres of milk.
- $Qty_{rp} = 10 * (\sum_{v} Q_{vrp} + Stk_{rp})$

Objective function

The objective is to minimize the total expected understocking and overstocking cost at each retail outlet for each product.

$$E(z) = \sum_{p}(\sum_{r}(\int_{0}^{Qtyrp}(Qtyrp - Xrp).frp(X).dx) * OSp) + \sum_{p}(\sum_{r}(\int_{Qtyrp}^{\infty}(Xrp - Qtyrp).frp(X).dx) * USp)$$

Constraints set

- $\sum_{v}\sum_{p} Qvrp \le Capr$
- $\sum_{r}\sum_{p} Qvrp \le Yv * VL$
- $\sum_{v}\sum_{r} Qvrp \le Supp$
- $\sum_{v} Yv \le N$
- $\sum_{p} Qvrp \le Dvr * VL$
- Non-negativity constraint.