

Inventory Deployment, Management, and Order Fulfillment in Multi-channel Retail/E-tail Organizations

Haoxun Chen

Full Professor, Supervisor of the PhD student
Industrial Systems Optimization Laboratory, Charles Delaunay Institute
University of Technology of Troyes, France
haoxun.chen@utt.fr

In recent years, large e-commerce companies or distributors such as Amazon, Alibaba, Walmart and Carrefour have promoted a new retail model that integrates their e-commerce sites, retail stores, and logistics services. This model or concept is built around the construction of a new ecosystem that merges online and offline retail channels, with consumers placed at the center of all managements. A supply chain in the new retail is usually composed of a central warehouse/distribution center, several off-line retail stocks and e-commerce depots that are located at multiple levels and different places and is thus a multi-echelon inventory system. Figure 1 shows the structure of such multi-echelon inventory system with multiple retail/e-tail channels. Key issues for successful implementation of this new retail model include strategic inventory deployment for the retail and e-tail sites, tactical inventory management of the underlying multi-echelon inventory system, and operational allocation of retail/e-tail stocks to on-line customer orders in order fulfilment. The objective is to deliver products ordered online or purchased offline by consumers quickly and on-time at the lowest cost. To achieve this goal, the decisions at the three levels (strategic, tactical, and operational) must be made in an integrated and optimal way to minimize inventory and delivery costs while ensuring a high service level to consumers.

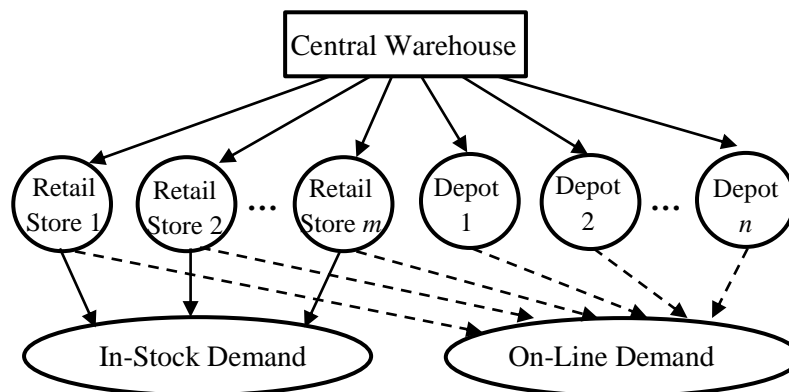


Fig. 1. Structure of a multi-echelon inventory system with multiple retail/e-tail channels

For a multi-echelon inventory system with multiple retail/e-tail channels, its inventory deployment is to strategically position inventory among all stocking locations in the system, its inventory management is to determine where to order, when to order, and how much to order for

inventory replenishment of each stock in the system, and its stock allocation for order fulfillment is to determine from which retail/e-tail stock each on-line customer order is delivered. Various costs must be considered in making these decisions, including inventory holding costs, shortage costs, order costs, and transportation costs.

In the literature, many articles have studied inventory deployment, inventory management, and order fulfillment independently. However, the study of inventory deployment, inventory management, and order fulfillment together and in an integrated way was rare. Moreover, most of these articles study distribution systems with a single warehouse and multiple retailers selling only one product to one type of customers, these systems are much simpler than the multi-echelon inventory systems we can find in e-commerce and new retail. The main challenge for optimizing a multi-echelon inventory system with multiple retail/e-tail channels is the stochastic nature of customer demands and the uncertainty of inventory replenishment lead time of each stock in the system. Because of these uncertainties, very few studies have addressed inventory deployment, inventory management, and order fulfillment in a distribution system that integrates both online e-commerce warehouses/distribution centers and offline retail stores. There is a big gap between the theory of inventory management and its application in such systems.

In this doctoral research project, we will study inventory deployment, inventory management, and order fulfillment in multi-echelon inventory systems arisen in e-commerce and new retail.

The doctoral student will conduct his/her research in Industrial Systems Optimization Laboratory (Laboratoire d'Optimisation des Systèmes Industriels or LOSI in French). The research activities of LOSI are focused on two types of systems: production systems and logistics systems. The proposed doctoral research project well fits into the strategy of LOSI to develop models and methods for effective logistics management in supply chains. More importantly, we currently have a collaborative research project on inventory management with Alibaba group, an e-commerce giant, and are well aware of real issues for managing multi-echelon inventory systems in e-commerce and new detail.

This doctoral research project aims to develop effective models and methods for integrated optimization of inventory deployment, inventory management, and order fulfillment in a multi-echelon distribution system with multiple retail/e-tail channels. More precisely, the project has the following objectives:

1. Propose integrated models for joint optimization of inventory deployment, inventory management, and order fulfillment in a supply chain with multiple retail/e-tail channels.
2. Develop effective methods/algorithms for the joint optimization of inventory deployment, inventory management, and order fulfillment.
3. Implement the models and the algorithms in computer program and evaluate them by numerical experiments on randomly generated instances and real instances.

The development of the models and methods in this project will be based on the methods of operational research, probability theory/stochastic processes, and machine learning in artificial intelligence, especially stochastic programming and reinforcement learning.

References

Kurt M. Bretthauer, Stephen Mahar, M.A. Venakataramanan, Inventory and distribution strategies for retail/e-tail organizations, *Computers & Industrial Engineering* 58 (2010) 119-132.

S. A. Torabi, E. Hassini, M. Jeihoonian, Fulfillment source allocation, inventory transshipment, and customer order transfer in e-tailing, *Transportation Research Part E: Logistics and Transportation Review*, Volume 79 (2015) 128-144.

Dong-Qing Yao, Xiaohang Yue, Samar K. Mukhopadhyay, Ziping Wang, Strategic inventory deployment for retail and e-tail stores, *Omega*, 37 (2009) 646-658.

Stephen Mahar, P.DanielWright, The value of postponing online fulfillment decisions in multi-channel retail/e-tail organizations, *Computers & Operations Research* 36 (2009) 3061-3072.