

Chapter 15

Dynamics of Supply Chains for Perishable and Non- Perishable Items

Narasimha Kamath

JDA Software, India

ABSTRACT

This chapter analyzes the dynamics of supply chains for perishable and non-perishable items and compares them. It starts with a single echelon supply chain with widely used inventory management and ordering policies; and then generalizes it to multi-echelon supply chain. Simulation experiments are conducted to match the results with literature and real-world scenario. It shows how spoilage information can be incorporated in the ordering decision to create highly responsive supply chain, which may not always be desirable. Amplification is lesser and stabilization is faster for supply chains of perishable items. ANOVA shows significant difference for the identified performance metrics under varying demand patterns and to a certain extent varies with the item type.

INTRODUCTION

Supply chain management involves managing the physical and information flow of materials and finished goods in a supply chain. In this chapter, we look at the intricacies of modeling a generic supply chain dealing with a perishable item. The differences arising mainly due to the perishable nature of the product are highlighted. As a starter, we first discuss a single echelon supply chain and study the inherent dynamics which are easier to explain and understand. It is then generalized to a four echelon supply chain and we perform rigorous analysis on it. The objective is to understand the chain dynamics when the supply chain has more players. We resort to simulation experiments to draw comparison with non-perishable items.

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Perishable items account for a major portion of the overall grocery and supermarket sales. The utility of these items diminish as they spend more and more time in a particular inventory echelon. After a certain time, such goods must be discarded. Many packaged food items have an expiry date specified on them. Some of the items that fall into this category are dairy products like cheese, ice creams, yogurt, paneer and flavoured milk drink; bakery products like sweetmeat, bread and biscuits; chocolates, snacks and beverages. Typical logistic activities of making such a product available from the producer to the customer are as follows. It is processed in a plant, sent to the distributor, who sells it to the wholesaler who in turn delivers it to the retailer. It is at this place that the customer purchases the product. By now the product would have undergone a lot of planning and coordination across the various players of the supply chain. Some of these activities would be the orders placed by each agent with its upstream supplier, the production rate at the plant, the transportation time between echelons and the available inventory at each echelon. One needs to understand that the market is dynamic and hence the customer orders are not deterministic. We present the experimental analysis of such a supply chain. The study of supply chain of perishable products is particularly important because they account for more than 50% of supermarket sales, and the potential for extra profit from managing these items has been estimated at 15%. The best practices available in the industry are analyzed by (Kamath & Saurav, 2014) in Indian context.

The dynamics of the supply chain has been evaluated by many researchers in many different ways. (Forrester, 1961) evaluates it using system dynamics simulations and attributes it to the structure and policies followed by the supply chain. (Kumar & Nigmatullin, 2011) have studied the system dynamics of a non-perishable food item to determine the behavior and relationships in a supply chain. Extensive literature analysis and a case study showing the need to analyze the dynamics of perishable items are provided (Kamath, 2005). (Sternan, 1989) conducted experiments in the form of “Beer Game” and attributed the oscillations exhibited by the system to the decision rule applied by the subjects, who typically underestimate the time lags between placing an order and receiving it. He suggests that the decision making process is dominated by locally rational heuristics that follow anchor and adjustment policy. Many of these experiments and simulations have used a four echelon supply chain to evaluate the chain dynamics for the non-perishable item category. We have therefore retained the same four echelon supply chain for perishable items as well. Similar structure and ordering policies are adopted in our analysis so as to draw comparison between supply chains of perishable and non-perishable items. In this chapter we analyze the change in dynamics on account of perishability through simulation.

One of the important aspects of SCM is controlling inventories. Managing inventory of perishable items is difficult because of their limited shelf life. Incorporating perishability in the analysis aided with technology indeed increases the overall profit for the channel partners (Piramuthu & Zhou, 2013). The two fundamental questions to be answered by any inventory control system are “how many” and “how often” to order. Some of the commonly used ordering policies in inventory management (Silver, Pyke & Peterson, 1998), are

1. **Order Point, Order Quantity (s, Q) Policy:** This is a continuous review policy where a fixed quantity Q is ordered whenever inventory position drops to or below the reorder point s . The inventory position includes the store inventory and the items ordered but not yet received (in the supply line).
2. **Order Point, Order Up to Level (s, S) Policy:** This is also a continuous review system where orders are placed to bring the inventory back to the order up to level S when the inventory position drops to or below the reorder point s . This has a variable replenishment quantity.

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