Data Analytics and Optimization for Product Distribution and Inventory Control for a Large Consumer Electronics Manufacturer

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Abstract We consider an electronics product distribution network for a large manufacturer firm. The distribution network has two distribution channels: direct distribution through air transportation to the retailers, and indirect distribution through distribution network to the retailers, where the network consists of a number of regional distribution centers, country distribution centers and frontier distribution centers. The direct channel bears no inventory but response time is relatively long due to its long distance to the retailers, while the indirect channel has short response time due to its frontier distribution center is near to the retailers. However, the unsold units in the indirect channel have to be disposed with high cost, thus the inventory level within the network must be controlled carefully.

To make best trade-off between the response time to retailers and the inventory holding costs, we develop a set of methods. Based on historical sales data, we first analyze the scenarios for different products in terms of channel selection and inventory replenishment by using clustering and data mining methods, and derive a set of rules. We then develop forecasting models for different scenarios by considering various ARMA (m, n) models and identified several models with low forecasting errors. We formulate the inventory optimization problem as mixed integer program (MIP) models for different scenarios and propose simple (s, S)-policy in case solving the MIP models is time consuming.

We show the proposed methods are very effective by simulating the product distribution processes on a real data set of nine months (sales, response times and inventory levels). In fact, we are able to reduce the inventory level by more than 40% and reduce the response time by more the 30% under the same service levels if the proposed methods were used.

Keywords distribution channel, response time, inventory control, scenario analysis, clustering, data mining, forecasting, simulation, mixed integer program, ARMA model, (s, S)-policy