Chapter 10
Managing Uncertain Inventory in Supply Chain with Neural Network and Radio Frequency Identification (RFID)

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ABSTRACT
Demand uncertainty leads to fluctuations in inventory position at each echelon of a supply chain causing bullwhip effect, which can lead to significant cost and loss of efficiency and waste of resources. One of the aspects that can reduce potential bullwhip effect is the sharing of real time information for which the recently mass produced Radio Frequency Identification (RFID) can be of great value. The use of RFID technology can also help in increasing the visibility of the flow of goods and material, keeping track of the location and quantity at each distribution centre and warehouses. This will also help in the periodic and near real time optimization of inventory level of goods and material. The data collected with RFID can be analysed in artificial Neural Network (NN) to forecast the future demand. In this chapter, a framework is proposed by combining RFID with artificial neural network so that lean logistics can be realized in the supply chain.

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INTRODUCTION

Inventory management is a critical issue of supply chain management. An efficient inventory management system can enhance the service level and improve the responsiveness of the customer requests. However, inventory management is a challenging task and it is difficult to estimate the demand quantity especially for the products that are newly introduced to the market. The unpredictable demand and dynamic consignment location leads to the difficulty in keeping track of the stock. As a result, it leads to high inventory cost, inadequate resource allocation and slow response to the customer request.

One of the ways to tackle uncertainty is to increase stock levels but it will increase the total cost of operation as well when the demand fluctuates and when there is a time lag in terms of collating sales figures and estimating demand. Such a situation can lead to bullwhip effect, which can be minimized through information symmetry across the supply chain. This will not only help in the visibility of inventory in terms of stock and usage rate on a real time basis but it can also support in demand analysis and forecasting.

In this chapter, logistics framework is proposed by combining the strengths of RFID and neural network (NN) for inventory analysis and demand forecasting of fast moving consumer products such as electronics and automobiles. Neural network has been widely used for pattern recognition and it can help in recognizing and predicting the changing demand pattern so as to formulate a better inventory management strategy. Therefore, we adopt this technique to develop the forecasting framework in this study.

This book chapter consists of nine main sections. The next section focuses on reviewing current methods on inventory management and related technologies. RFID-based inventory management system and its architecture are presented in third section. The use of NN for demand forecasting is shown in the fourth section. A case example to illustrate the use of the proposed model is given in the fifth section, while results are discussed in the sixth section. The seventh section provides solutions and recommendation for supply chain innovation emerging from the study. The last two sections are dedicated to future research directions and concluding remarks.

THE TREND IN RFID BASED MODELLING

The quantitative forecasting method can be generally classified as time-series model and causal model. Time series model includes naïve forecast, moving average (MA) and autoregressive (AR), exponential smoothing (ES), double exponential smoothing (DES) and triple exponential smoothing (TES). In causal forecasting method, a forecast of the quantity of interest (the dependent variable) is obtained by relating it to one or more of independent variables such as lead time, customer satisfaction and product reliability.

Saygin (2006) has proposed the use of forecast-integrated inventory model under simulation environment and showed that the model combined with RFID can produce the desired level of system performance in terms of lowering manufacturing costs and inventory levels. RFID can also be used for managing ordnance inventory with multiple attribute utility structure to realize the non-cost benefit such as safety, manpower issues and ROI analysis (Doeer et al., 2006). Choy et al. (2009) use a case based reasoning method for selecting material handling equipment and the shortest order picking path by using RFID. The use of RFID for inventory accuracy was examined by Uçkun (2006) and Uçkun et al., (2008) and showed that RFID investment can be highly beneficial for sharing inventory information within entities in a supply chain.

Demand and lead time are most uncertain factors for inventory management. Croston’s model (1972) was claimed as unbiased and has better