RFID Impact in Supply Chain: Innovation in Demand Planning and Customer Fulfillment

What process changes can a Consumer Packaged Goods (CPG) company make in order to utilize Radio Frequency Identification (RFID) technology to improve customer service and reduce cost? This thesis proposes a process change in an RFID-enabled replenishment system. In addition, it gives an overview of RFID technology, analyzes the combination of different parameters in the replenishment process, and shows the best practice in current technology.

RFID is a powerful technology for automatically tracing and tracking objects. This technology has existed for decades and RFID tags have common applications such as cell phones, toll collection systems, and proximity security systems. However, only recently has RFID technology been tested in the operations of merchandise supply chain management.

*RFID Journal* has reported a number of RFID mandates since 2003. In June 2003, as one of the leading sponsors of the MIT Auto-ID Center, Wal-Mart announced that it expects its top 100 suppliers to be RFID complaint at the case and pallet level by January 1, 2005. In addition, the US Department of Defense (DoD) proposed a similar mandate shortly after Wal-Mart’s announcement. The Food and Drug Administration (FDA), meanwhile, stated in its report “Combating Counterfeit Drugs” that, by uniquely tracking and tracing products, RFID could be one possible solution to drug counterfeiting problems. Furthermore, in January and February 2004 respectively, Metro Group, a German retailer, and Target Corporation, a U.S. general merchandise retailer, issued RFID mandates to their suppliers. RFID technology will provide real-time tracking ability across the supply chain and give birth to the next generation of demand planning and inventory management.

The future of the real-time supply chain relies not only on technology development, but also on business process innovation in both retailers and manufacturers that establishes closer strategic relationships among supply chain partners. This thesis discusses the vertical relationship between vendors and retailers in both the barcode and RFID enabled environments. Its purpose is to find best practice in demand planning and customer fulfillment for vendors to improve customer service and reduce cost. Interviews were used to collect the information about current processes. A model was built to simulate the customer demand and inventory record accuracy, and this tool was used to analyze the different processes of demand planning and customer fulfillment.

**Scope and Approach**

This thesis focuses on the process improvement in current barcode system and future RFID system at case and pallet level. It compares four different processes in demand planning and customer fulfillment to find out the practice that maximize the value of information sharing. The major benefit of RFID is the automation in information collection. A replenishment system that maximizes the value of the collected information would be a process model for RFID implementation.
According to the literature review, the important parameters in improving supply chain performance are: (1) sharing demand information, (2) reducing lead-time, (3) increasing inventory review and replenishment trigger frequency, (4) increasing the number of observations when forecasting and, (5) sharing inventory information. Four processes are compared in the model.

In order to compare the performance and showing the important parameters in replenishment systems, we make the sensitivity analysis in the model. The sensitivity analysis include (1) reducing the review period, which equals to increasing inventory review and replenishment trigger frequency in this model, (2) reducing lead-time, and (3) increasing number of observations.

**Process 1: Conventional Process with Orders from Stores**
The conventional process means stores generate forecast based on the sales and in-store inventory level. Then the stores place orders to the retailer DC. The retailer DC forecasts DC demand according to the orders received from the stores. Based on the forecast and its inventory level, the retailer DC will then place orders to the vendor. The vendor will forecast based on the orders it receives from the retailer DC, and then places its orders to its plant.

**Process 2: Conventional Process with Internal POS Data used in Retailer DC**
In this conventional process, all the stores send their POS data rather than their replenishment orders to the retailer DC. The retailer DC forecasts DC demand based on the POS data and places retailer DC orders to the vendor. In this way, the processes of store forecasting and ordering are eliminated. The vendor DC then forecasts its demand and places orders to its plant.

**Process 3: Vendor Managed Inventory (VMI) to DC Level**
VMI means the retailers share the retailer DC information with vendors. The stores forecast their demand based on the end-consumer demand, and place orders to the retailer DC. The orders that the retailer DC received from the stores are available for the vendor DC. The retailer DC will also let the vendor know the inventory level of the SKUs in the retailer DC, which managed by VMI. ABC then forecasts for the retailer to replenish the inventory in the retailer DC. ABC forecasts for its DC inventory and place orders to its plant. In this case, the inventory in retailer DC is owned by the vendor.

**Process 4: VMI to Store Level**
The vendor receives stores’ POS data and forecasts based on those data. No formal orders will be placed. This means both the forecast errors in the store level and the retailer DC level are eliminated. The retailer DC does only cross-docking. The cross-docking in retailer DC may not be necessary if no cost advantages in transportation can be found. Cross-docking helps to reduce less than truck load shipping. Collaborate forecasting should be used in this business model for promotion activities.

In order to compare the performance of different processes, we assume that all the stores, retailer DC, and vendor DC should reach 99%~100% average fill rate, which help to prevent out of stock by using inventory buffer. This allows us to compare the on hand inventory level of different processes.
Results of the Analysis

The results show that, in order to improve the shelf availability and reduce cost, suppliers may consider (1) using Point of Sale (POS) data as a demand driven signal to facilitate Vendor Managed Inventory (VMI) to store level, which eliminates the retailer ordering process, and (2) monitoring the store traffic and backroom inventory by periodically checking the POS data and the information collected at the backroom-in and backroom-out points. Comparing the in-store traffic in different data points can reduce the time of out-of-stock, and reduce the possibility that products are in the backroom but not on the shelf. Retailers might still need their distribution center (DC) to reduce the transportation cost, but the retailer DC should do more cross-docking activities rather than build up inventories for stores.

Retailers will receive immediate benefits from this process change. Suppliers, on the other hand, will also enjoy significant reduction in inventory and increased product availability at the store level. Increasing the replenishment frequency, reducing the overall lead-time, and collaborating on promotion plan will all have notable impacts on improving customer service level and reducing on-hand inventory. The key of RFID implementation is to broaden the collaboration with retailers.

Result for vendor: VMI helps the vendor reduce its inventory. VMI to store level is the best practice for the vendor to maintain the customer service level at 99%~100% while reducing inventory more than 25%. If the vendor increases its inventory review and replenishment frequency and uses VMI to store level process, its inventory level can reduce more than 70%, while still maintaining the same customer fill rate. On other words, the vendor can use fewer inventories to provide higher customer service. Products with high value and strong brand can get more benefits from this business model.

Result for retailer: eliminating the order processing by using POS data to do replenishment will improve retailer’s inventory control significantly. Retailers can save more than 45% inventory already if they start to use POS data as replenishment trigger instead of store orders. Vendor Management Inventory will help retailer gain advantages because the inventories in retailer DC will be owned by the vendor. Different demand patterns have different impacts on the inventory levels. Detail analysis can be done if real demand information is available.

Based on this analysis, we can conclude that vendor management inventory to store level is the best practice in terms of the value of information sharing. In reality, companies should build a business case first to check the implementation cost and relative benefits. For products with high value and strong brand power, VMI-to-Store can bring more benefits for the vendor to improve customer service and reduce inventory.

The result also shows that if the vendor reduces its supply lead-time for one day, the inventory level of VMI model will reduce 2~7%. However, the relationship between the reduce lead-time and reduce inventory cost shows not linear. In this model, the benefits of increasing observation are not clear. The inventory level has almost no changes after increasing observation data points. However, we strongly suggest using real demand information testing this scenario because the demand data used in this analysis may not be able to present the real demand fluctuation.

Now, the question is how RFID can bring extra benefits to this business model. As we mentioned
before, the major difference between RFID and barcode system is that RFID enabled the automation of material handling and decision-making. According to the interviews with managers in anonymous stores, the current accuracy of inventory report in retail stores is about 88~95%. Stores normally assume that they receive the right products as listed in their shipping bills. In addition, the store inventory in backroom is often based on the assumptions rather than on physical cycle counts. In retail stores, the improved inventory accuracy could be one of the most important benefits for RFID implementation at the case and pallet level.

RFID-enabled VMI to store level has several scenarios. POS data are available in all the RFID scenarios. In different scenarios, we assume products are tagged only at the case and pallet level, and the reading accuracy is 100%.

<table>
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<tr>
<th>Scenarios</th>
<th>Extra Information available</th>
<th>vendor benefits from the extra information</th>
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<tr>
<td>RFID implementation in four walls</td>
<td></td>
<td>benefits in four-walls</td>
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<tr>
<td>1. The vendor receives RFID data when retailer DC receives products.</td>
<td>Receiving confirmation from retailer DC; POS data</td>
<td>Eliminating discrepancy; reduce complaining</td>
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<td>2. The vendor receives RFID data when retailer DC receives and ships products. Assume retailer DC only ship products to its stores.</td>
<td>Accurate inventory of retailer DC</td>
<td>Accurate retailer DC inventory management</td>
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<td>3. The vendor receives RFID data from retailer DC and the stores when their backrooms receive the products.</td>
<td>Receiving confirmation from retailer store</td>
<td>Preventing out-of-shelf based on estimated backroom inventory</td>
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<tr>
<td>4. The vendor receives RFID data from retailer DC and stores, including both in and out.</td>
<td>Accurate inventory of store backroom</td>
<td>Preventing out-of-shelf based on accurate backroom inventory; reduce shrinkage</td>
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<td>5. RFID tags at the item level and readers can read all the tags in the backroom and front store.</td>
<td>Accurate inventory of shelf stock</td>
<td>Accurately manage out of shelf; prevent theft; improve promotion management; better manage perishable products</td>
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Different RFID scenarios can bring different information. We focus on the store level to see what value RFID technology will bring to the vendor and the retailer. We compare the stock out level in two scenarios: (1) no RFID tags on products, (2) RFID data are available from the backroom in and out points.

In the model, we receives the result that if the inventory accuracy improve 1%, RFID may help to reduce the out-of-stock 0.02~0.06%. This number may not provide too much information because the result should be different for different settings of the backroom inventory. If the buffer inventory in backroom is higher, then RFID is less benefit; if the buffer inventory in store is very lower, RFID helps the retailers and vendors better control the out of stock on shelf. In other words, RFID may help to reduce store backroom inventory, but this benefit is limited at case and pallet level, and this benefit is different for different products.
Inventory accuracy can be improved after RFID implementation. The improved inventory report helps to reduce the stock out on shelf but the benefits are not significant. This benefit is more notable for the products with short life cycle and promotion products as we mentioned before. On another hand, the accurate backroom information will help the store employee do in-store replenishment more efficiently and accurately. Without the inventory information in backroom, employees have to go to the backroom to check how many products still in there and which location the products are. With the RFID information about the products available, employees will be able to know immediately how many products are available in the backroom and handle exceptions efficiently. For retail and CPG companies, a pilot test in store backroom is strongly suggested before the RFID implementation. Pilot test helps them identify appropriate inventory policies in the store. The information collected from the testing can also be help for quantifying the benefits from RFID implementation.

**Summary of Major Findings**

RFID implementation at the case and pallet level has limited benefits in demand planning and customer fulfillment. However, companies can find significant benefits from process changes. Before implementing RFID, companies need to first check their current business process, and gain benefits from the process improvement. Using POS data as a demand driven signal, VMI to store level is the best practice, if demand and inventory information can be shared between retailers and vendors. Vendors can also gain significant benefits from reducing lead-time and increasing the frequency of inventory review and replenishment. Furthermore, retailers and vendors can still estimate shelf status in the front-store by using POS data and store receiving information.

Sensitivity analysis in this thesis shows that increasing the frequency of inventory review and replenishment and reducing the lead-time of customer fulfillment can notably reduce the vendor’s inventory level and improve customer service.

For RFID system, one of the major benefits in the demand planning and customer fulfillment is to improve inventory accuracy but the benefits are limited if the tags are not at item level. For example, the improvement of demand planning in promotion activities cannot be realized if tags are not at item level. Without unique item-level tagging, vendors cannot separate the promotional items sold from the normal items.

This thesis shows the value of the information collected from the store backroom. Retailers and vendors should share more demand and inventory data if the information exchange infrastructure is ready. Vendors should also analyze the data to derive patterns from them. One example mentioned in this paper is to use the POS data and the inventory information in the store backroom to prevent the events of empty shelves.

To conclude, this thesis focuses on the vertical process between the vendors and the retailers. Some topics, such as transportation management and discrepancy reconciling, are still left for further discussion. In addition, this thesis makes assumptions about demand pattern because of the limited information available. Using the similar approach, companies can build business cases to evaluate the RFID benefits for different products.