INVENTORY CENTRALIZATION IN AN ELECTRONICS RETAIL BUSINESS

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Abstract

This research examines the impact of changing a distribution system from a direct distribution system (from supplier direct to each store) to a DC system, in the EGR Company (a pseudonym), which is a multi location electronic retail company in Thailand. The DC system is an inventory centralization distribution system that centralizes inventory in one place for distribution to other locations. Each store keeps inventory only at safety stock level, most inventory being kept at a DC.

The research statistically compares a three-month period of implementing a DC distribution with the same period of the previous year in order to eliminate the seasonal nature of the product sales volume.

The total distribution cost consists of the average aggregated stock level, transportation cost, and inventory management and administration cost, and the researcher expected a reduction after the company implemented a DC system. Indeed the results did show that a DC system can reduce the total distribution cost. However, the results of the impact on transportation cost are surprising, as weighted sales volume transportation cost is reduced by a DC distribution system which is the opposite to what was expected.

INTRODUCTION

The EGR Company is a multi-location electronic goods retail company, which has seven branches in southern Thailand. It has 25 product categories with well-known electronic brand names such as Samsung, JVC, Philips, and Electrolux. There are 2,200 SKUs in these 25 products.

The long-term competitiveness of any retail company depends on the success of its logistic management system capabilities, which would improve its market position and financial performance, create new industry standards and new niche markets, and renew the organization.

*This is a shortened version of Mr. Pattanavekin's MSc Research Report.

The company's three problems were:

1. Low inventory turnover ratio, defined as:

$$Inventory\ Turnover = \frac{Cost\ of\ Goods\ Sold}{Average\ Inventories}$$

(Average inventories = (Beginning inventories + Ending Inventories) / 2).
The company had a turnover ratio of 1.8, but the industry standard is 2.2.

2. High level of sunken inventories
A high level of sunken inventories reveals waste in inventory investment and inefficient inventory management as well as the inventory turnover ratio.
3. Low level of customer service
The company did not have enough inventory to meet customers' instant demands, and also had a long lead-time of ordering that product.

An informal survey of the company sales clerks found that 15% of customers who came to the store could not find the product they wanted there and then. 7% of those customers would wait for the order only if it took no longer than three days. But the company could serve only 40% of waiting customers, by transferring the product from another branch. The company loses the other 60% of waiting customers due to a long lead-time of ordering from suppliers.

Inventory management is one of the key success factors of a retail business in order to deal with the uncertainties and variability of demand. The company any was affected by a phenomenon called the "bullwhip effect", the demand fluctuation caused by rapid changes in consumer demand (Russell & Taylor, 2002). Distorted information, or lack of information, from one end of the supply chain is one of the main causes of uncertainty, and it can lead to excessive inventory, poor customer service level, lost revenues, ineffective transportation, and high costs. It causes retailers to maintain and keep a high inventory level to serve customer demand (Lee, et al., 1997).

A strategy to solve these issues is to have a distribution center (DC). This can reduce inventory cost, inefficient inventory management problems, excessive inventory problems, and increase inventory turnover (all whilst retaining a good service level). However, DC brings an operation cost, and may increase the transportation cost. Faced with all its inventory problems, which caused poor financial performance and continuous loss of market share, the Board of Directors decided that a solution could be a distribution center (DC) or warehouse distribution system. A warehouse system would replace the system whereby each vendor delivered their products directly to each branch.

The alternative solution would be to improve demand forecasting. But to achieve that needs specialists, a high level of computer software, a long series of historical data, and good collaboration with suppliers. It is a long-term development.

In this research, the major limitation was time. It needed at least one year to collect data of ordering, sales, stock-out data, transportation cost, and overhead cost. However, the research had to be based on a three-month period, and the data might not be representative. A major constraint of the Company is that the warehouse can only be at the headquarter location because of area constraint, budget constraint, and operational human resource constraint.

LITERATURE REVIEW

Inventory control refers to the techniques used to ensure those stocks of raw material or other supplies; work-in-progress and finished goods, are kept at levels that provide maximum service level at minimum costs (Leeders, 2002). It consists of all the activities and procedures used to ensure the right amount of each item is held in stock (Waters, 1999).

Lambert (2002) postulated the five aims of inventory as:

1) To enable the firm to achieve economies of scale
2) To balance supply and demand
3) To enable specialization in manufacturing
4) To provide protection from uncertainties in demand and order cycles
5) To act as a buffer between critical interfaces within the supply chain

Formulation of an inventory policy requires an understanding of the role of inventory in manufacturing and marketing (Leenders, 2002). Inventory serves the following purposes within a company:

1) To provide both internal and external customers with the required service levels in terms of quantity and order fill rate.
2) To have certain present and future requirements for all types of inventory to avoid overstocking while avoiding bottlenecks in production.
3) To keep costs to a minimum by variety reduction, economical lot sizes, and analysis of costs incurred in obtaining and carrying inventories.

Waters (1999) explained that inventory is a major use of capital, and the objectives of inventory management are to increase corporate profitability, to predict the impact of corporate policies on inventory levels, and to minimize the total cost of logistics activities. Corporate profitability can be improved by increasing sales volume or cutting inventory costs. Increased sales are often possible if high levels of inventory lead to better in-stock availability and more consistent service levels. Low inventory levels can reduce fill rates on customer orders and result in lost sales. However, the costs associated with high levels of inventory usually exceed the benefits derived. Methods of decreasing inventory related costs include such measures as reducing the number of back orders or expedited shipments, purging obsolete or dead stock from the system, or improving the accuracy of forecasts (Leenders, 2002).

Inventory has a value, so keeping a store of goods costs money. However, there are many valid reasons why a firm keeps in storage a certain amount of inventory and often more than is required in the next immediate period. In term of a retailer, finished goods held by a distributor or even wholesale distributors for retail outlets always have a certain amount of inventory on hand, for various reasons. Stock and Lambert (2002) state the reasons for carrying inventory:

a) Variation in customer demand
   Customer demand varies from period to period, and as it is not always easy to forecast these needs, extra supplies are kept in order always to be able to satisfy the customer and provide the best service level. In addition, it is often more economical to hold inventory rather than place emergency orders for clients.
b) Display of products
   Holding inventory allows display of products to aid the sale. In some cases, it may not be possible to sell products after they have been used for display purposes. Alternatively, they will be sold at a marked-down price.
c) Price discounts
   If finished products are purchased in bulk, discounts are often available. Thus, it is more economical to take advantage of lower unit prices and store what is not immediately required.
d) Anticipated price increases
   Finished goods may be held in anticipation of price increases. For example, an increase in value added taxes announced by the government, or tax increase on petrol, cause consumers or retailers to stock up on the finished product.

Holding inventory is a high level cost involving a huge amount of money. Some inventories are required beyond the number of stocking locations, at least at the safety stock level. Thus, the retailer which has many branches or locations, would require a lot of aggregate inventory in order to maintain safety stock of each location. This brings high unnecessary investment in inventory. This research works on this issue to offer the best solution.

Inventory Control Systems

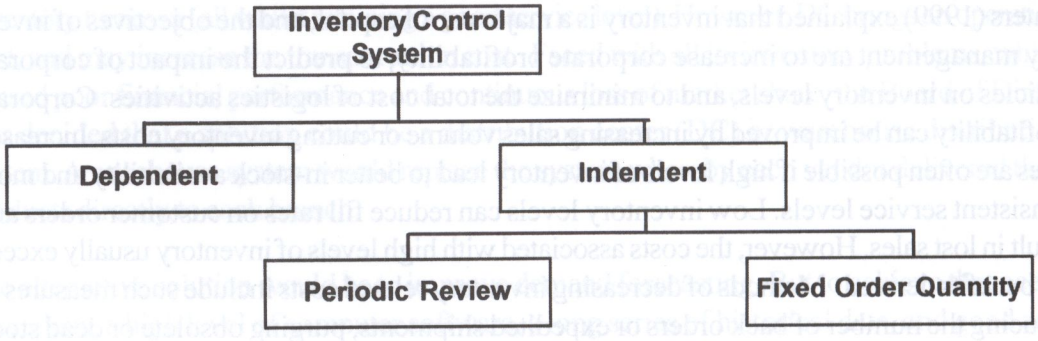


Figure 1: Inventory control systems

The details of Figure are explained.

1. Independent demand inventory is influenced by market conditions and not related to production decisions for any other item held in stock. In manufacturing, only end items (Waters, 1999), the finished products, are sold to customers. Demand for them depends solely on the requirements and demand of the consumer. Managing these inventory items requires forecast information on consumer needs.

   Independent demand models can use either fixed order quantities or periodic reviews.

A. Fixed order quantity systems place an order of fixed size whenever stock falls to a certain level. The system needs continuous monitoring of stock levels and is better suited to low, irregular demand for relatively expensive items.

B. Periodic review systems place orders of varying size at regular intervals to raise the stock level to a specified value. For example, supermarket shelves may be refilled every evening to replace whatever was sold during the day. The operating of this system is lower and it is better suited to high regular demand of low value items.

2. Dependent demand inventory is derived from the product decisions for its "parent"; it is an item manufactured from one or more component items, usually assemblies or parts used in the manufacture of the final consumer product.

This research focuses on "independent demand inventory", which is appropriate to retail businesses that sell the finished goods. To control independent demand inventory efficiently with a limited budget, the right model has to be selected for a distribution system for the business.

Independent Variables

In addition to knowing how much inventory to order, it is also necessary to know the order point, or the date at which to place the new purchase order. This quantity would normally be when the current inventory level has fallen to a specific minimum. An order point is based on the lead-time (the time between placing the order and receiving shipment) and the estimated amount of inventory that is going to be consumed or demanded during this lead-time period. The value of demand is critical. If it were higher than expected, there would be the risk of stock-outs. If demand were low, inventory levels would be high with the associated high stocking costs (Waller, 1999).

A supplier may be extremely reliable and always deliver as promised, and the lead-time will not be a problem. However, generally, there are delivery delays, raw materials are short, or a machine has broken down, and the lead-time is longer than planned and so safety stock may be needed to cover unexpected situations.

Service level in inventory situations is for clients whose proportion of orders can be completed by using existing inventories of finished goods. Service levels are given as a percentage. Thus, a 95% service level means that on average 95% of customers' orders are fulfilled from

current inventory. The other 5% will not be filled because a stock-out is experienced. This 5% of orders will have to be filled at a later date (Waller, 1999).

A service level is the ability to meet the demands of customers from stock. Leenders (2002) defined the method of calculation service level as the number of times an item is provided on demand, divided by the number of times an item is demanded.

Safety stock – To attempt to avoid stock-outs resulting from the uncertainties, firms might keep a safety stock. This safety stock is dead inventory; it provides a safeguard, but adds to inventory carrying costs. Since there is a cost associated with holding or carrying inventory, or a safety stock, the risk of a stock-out must be traded off against the cost of carrying inventory. The objective is to carry the optimum level of inventory. The more inventories that are carried, then the lower is the probability or risk of a stock-out; however, the greater is the holding cost. The more the variability in customer demand or supplier lead-time, then the greater the amount of safety stock required to achieve an established service level (Waller, 1999).

Distribution Center

A good solution to inventory problems is often a Distribution Center (DC), as a principal part, the order processing element, of the entire order fulfillment process. Distribution centers are usually demand driven.

Distribution centers are the basis of a supply network as they allow a single location to stock a vast number of products. Some organizations operate both retail distribution and direct-to-consumer out of a single facility, sharing space, equipment, labor resources and inventory.

Since a large retailer might sell tens of thousands of products from thousands of vendors, it would be impossibly inefficient to ship each product directly from each vendor to each store. Many retailers own and run their own distribution networks, while smaller retailers may outsource this function to dedicated logistics firms that coordinate the distribution for a number of companies. A distribution center can be co-located at a logistics center.

Distribution Center and Inventories Management

Distribution Requirements Planning is the process in the supply chain to help ensure that finished goods destined for a client reach the right location, on the right date and in the right quantity. The supply chain covering the distribution requirements planning may be from the manufacturer through the various distribution centers to the retailers in a service firm. The distribution requirement plan might be a pull or push system (Simchi & Kaminsky, 2003). A pull system is the most common type of planning approach and for many it is the only distribution requirements plan. A pull system is when the outlet at the lowest level, or end of the

distribution network, usually the retailer, initiates the order. The retailer "pulls" the products through the distribution, or supply chain, network. The retailer has its own ordering policy and the supplier only makes a delivery when a specific order has been made (Simchi and Kaminsky, 2003).

The demand from each retailer imposes a master production schedule (MPS) on the manufacturer, which may not be optimum. The manufacturer loses some control of his planning process and has to be flexible to accommodate customer demands. In some instances the pull system may impose a MPS on the manufacturer that is not feasible, when, for example, insufficient resources are available. If a just-in-time system is in place the manufacturer will have more flexibility.

In a "push" system, the supplier at the beginning of the network, usually the manufacturer, produces the finished products according to the master production schedule (MPS), which would have been established according to estimates of clients' demands and then modified to suit the company's resource available at the manufacturing site. Material is pushed through the distribution channel when the products are ready. The flow of material may not necessarily be in harmony with the needs of the final retail outlet. As a result, the retailer accumulates too much stock.

A hybrid of the push and pull systems in distribution requirements planning is to use a ***distribution center*** as the inventory buffer to avoid stock-outs.

Discussion of Previous Studies

Zinn, Levy, and Bowersox (1989) measured the effect of inventory centralization/ decentralization on aggregate safety stock by using the square root law in order to approximate the changes in aggregate safety stock resulting from changes in the number of stocking locations used in the distribution of a product. They collected data from four stores of a department store chain. Unit sales per store were obtained for a typical product – men's white Jockey underwear, size 36. They find the reduction in aggregate safety stock was made possible by centralizing inventories. Their findings guide us to identify how to reduce inventory cost without reducing customer service level in an environment of multiple locations, as in the EGR Company.

Baganha and Cohen (1998) review some empirical results concerning the destabilizing effect of inventories. They find that wholesalers can, in fact, introduce a degree of stabilization into the supply chain by transmitting an order process to manufacturers with variability lower than the variability inherent in the retailer replenishment order process. They also noted that there are no models available for the study of the impact of inventory policies on the variability of demand throughout the manufacturing/ distribution supply chain that takes the stochastic link-

ages associated with the multi-echelon structure of such systems into account. Beyond what they find, in order to stabilize effect of inventory or reduce variance amplification throughout the supply chain, they need a distribution center to be transmitting an order process to manufacturers, instead of a retailer replenishment order process, which is like the centralization of order process. But they remind us that each location only has local information, so the sharing of information in the network is necessary for the occurrence of a stabilization effect of inventory.

Simchi and Kaminsky (2003) also debate centralized versus decentralized distribution systems. Their reasoning is very useful for this present research to determine the independent variables related to whether a decentralized or centralized distribution system is appropriate to the EGR Company.

Safety stock decreases as a firm moves from a decentralized to a centralized system. The amount of decrease depends on a number of parameters, including the coefficient of variation and the correlation between the demands from the different markets. While the centralized and decentralized systems may have the same total safety stock, the service level provided by the centralized system is higher. The magnitude of the increase in service level depends on the coefficient of variation and the correlation between the demands from the different markets. Overhead costs typically are much greater in a decentralized system because there are fewer economies of scale. As to customer lead-time, since the warehouses or distribution centers are much closer to the customers in a decentralized system, response time is much shorter.

The impact on transportation costs depends on the specifics of the situation. On one hand, as we increase the number of warehouses, outbound transportation costs decrease because warehouses are much closer to the market areas. On the other hand, inbound transportation costs increase. Thus, the net impact on total transportation cost is not immediately clear.

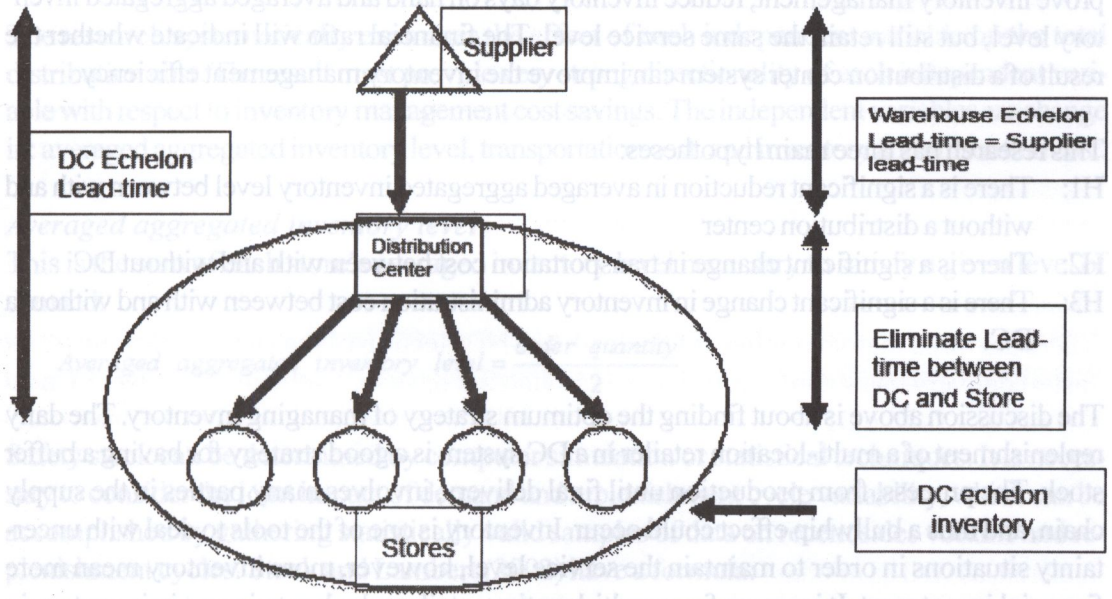
Finally, safety stock, service level, overhead costs, customer lead-time, and transportation costs are our independent variables that we have to measure and be concerned with in order to reach our research answer.

The Conceptual Framework Model

The chart below illustrates the *Conceptual Framework* of this research.

If we utilize the distribution center to stock inventories and distribute to each store, and we can determine absolutely the length of the lead-time for each store, then we can reduce the aggregated stock level of each product in each store. But we have to compare the benefit of utilizing DC against transportation cost and inventory administration cost.

Figure 2: How DC system reduces Echelon lead-time.



Source: Sichi-Levi & Kaminsky, 2003.

A DC distribution system can determine a reliable delivery schedule from warehouse to store rather than a direct distribution system where a supplier makes a delivery to stores individually and independently, and long lead-times might occur. When a DC distribution system could eliminate the lead-time from warehouse to store, the averaged aggregated stock level would be less. Then inventory capital of the company would be less, but the company still has the same service level.

The concept of eliminating lead-time from DC to each store is the key factor. Eliminating lead-time from DC to each store, the company can make each store keep inventory only at safety stock level. It means that DC can serve each store at nearly 100% service level (which is our only assumption).

The other variable is inventory administration cost; the conclusion about overhead cost is mixed. A DC distribution system changes the operation of the company by centralizing the inventory management at the head-office. The centralization of inventory management also gains the benefit of economies of scale in ordering and saving resources in the management operation in each store rather than decentralization. However, decentralization of inventory management may respond to the local demand better than centralization, which can reduce lost sales opportunities.

We expect the outcome from this model of a DC system (distribution center system) to improve inventory management, reduce inventory days on hand and averaged aggregated inventory level, but still retain the same service level. The financial ratio will indicate whether the result of a distribution center system can improve the inventory management efficiency.

This research has three main hypotheses:

H1: There is a significant reduction in averaged aggregated inventory level between with and without a distribution center

H2: There is a significant change in transportation cost between with and without DC

H3: There is a significant change in inventory administration cost between with and without a DC.

The discussion above is about finding the optimum strategy of managing inventory. The daily replenishment of a multi-location retailer in a DC system is a good strategy for having a buffer stock. The process, from production until final delivery, involves many parties in the supply chain, and thus a bullwhip effect could occur. Inventory is one of the tools to deal with uncertainty situations in order to maintain the service level, however, more inventory mean more financial investment. It is worse for a multi-location retailer who has to invest in inventory in each location.

RESEARCH METHODOLOGY

The methodology is a quantitative analysis which uses historical and current data from the EGR Company to test the impact of implementing a distribution center system.

The data used is for three months, July-September 2008 and July-September 2009. The 2008 period is when the EGR Company was using the direct distribution model. The 2009 period is when the DC distribution model was implemented.

Out of the company's 25 product categories, which have 2,200 SKUs and which move incessantly throughout the year, only AA products (high profit, high turnover) are used in this research. There are only two AA categories: Refrigerator, and Washing Machine.

The data analysed:

a) Sales information by products, overall sales information
b) Gasoline expenses and depreciation in transportation
c) Lead-time of each product from supplier to store
d) Lead-time of each product from supplier to DC
e) Averaged inventory on hand of each product in each store, monthly
f) Administration expense in inventory management

Operationalization of Independent and Dependent Variables

The research systematically examines the effect of each independent variable on the total distribution cost. The result must provide very strong directionality of each independent variable with respect to inventory management cost savings. The independent variables are change in: averaged aggregated inventory level, transportation cost, and inventory administration cost.

Averaged aggregated inventory level

This is the sum of each store's averaged inventory level necessary to satisfy a given level of demand:

$$Averaged\ \ aggregated\ \ inventory\ \ level = \frac{order\ \ quantity}{2}$$

Safety stock can be determined by computer simulation or statistical techniques. It is necessary to consider the joint impact of demand and replenishment cycle variability, which can be accomplished by gathering statistically valid samples of data on recent sales volume and replenishment cycles. Stock and Lambert (2002) have a formula:

$$Safety\ \ Stock\ \ level = Z \cdot \sqrt{Avg\ \ Lead\ \ Time * \sigma_D^{\,2} + Avg.\ \ Demand^2 * \sigma_L^{\,2}}$$

Where Z is the target service level (expected to be 99.5% in the DC model to eliminate the lead-time from DC to store.

The average amount of inventory on hand is equal to the safety stock plus the replenishment quantity. There are trade-offs between the replenishment quantities to achieve a specified probability of being able to fill orders from stock (Herron, 1997).

Service level

The α service level is an **event-oriented** performance criterion. It measures the probability that all customer orders arriving within a given time interval will be completely delivered from stock on hand, i.e. without delay.

Two versions are discussed in the literature, differing with respect to the time interval within which the customers arrive. With reference to a *demand period*, α denotes the probability that an arbitrarily arriving customer order will be completely served from stock on hand, i.e. without an inventory-related waiting time (period α_p service level):

$$\alpha_p = Prob(Period\ \ demand \leq Inventory\ \ on\ \ hand\ \ at\ \ the\ \ beginning\ \ of\ \ a\ \ period)$$

In order to determine the safety stock that guarantees a target α_p service level, the stationary probability distribution of the inventory on hand must be known. This version of α is also called *ready rate*.

Transportation cost

Total distribution cost is defined as:

Total distribution cost = aggregated inventory level + transportation cost + admin cost

With distribution center utilization, ERG Company has to bear the transportation cost instead of pushing it onto the supplier, as in the original direct distribution model. Therefore, it is expected that the transportation cost will increase. The transportation cost is weighted by sales volume in order to obtain the real transportation cost incurred by sales.

Inventory management cost

Typically, these costs are much greater in a decentralized system because there are fewer economies of scale. Inventory which is centralized may gain economies of scale in big lot orders and bargaining power from the supplier. Moreover, the inventory centralized system may gain an extra benefit from the supplier because the supplier delivers to only one place (DC) rather making a shipment to each store.

It is difficult to calculate the change in inventory administration costs, because there is no fair measure for an centralized system in an electronic goods retail business. Since the price of electronic goods decreases all the time, it is hard to separate the benefit of economies of scale from the perpetual price reduction. Therefore, the inventory administration cost is measured by using only the extra benefit that the company can gain from the supplier.

Statistical Treatment of data

First, we calculate the different scores, by subtracting each variable of a direct distribution system (before implementing a DC distribution system) from each variable of a DC distribution system. We also add together the changes of each variable to find out the impact of the distribution system change on total distribution cost.

Then, we employ t-statistics and z-statistics to determine if changes in measured attributes are significantly different from zero in order to test our hypotheses. The t-statistic is computed to test whether the mean data changes are significantly different from zero, and the Wilcoxon signed-rank test is used to test whether the median changes are significantly different from zero.

DISCUSSION OF RESULTS

Overview

The main effects on the company sales are classified into two categories:

External Environment

1. Political and Economic situation – the political situation in Thailand has affected the whole country's economic system from mid-2008.
   EGR Company's sales volume was affected by the political situation. Electronic goods have high elasticity to income; loss in customer confidence and liquidity problems in other businesses had a direct impact on electronic goods sales volume.
2. Swine flu – a new spreading virus in the middle of 2009.
   This virus had a direct effect on EGR Company, but it was just a short-term effect.

2. Internal Environment
   One branch was set up at the beginning of January 2009. As there was no comparable data for this branch, it had to be eliminated from the study sample.
   The company changed its distribution system from a direct distribution system to a DC distribution system in July 2009.

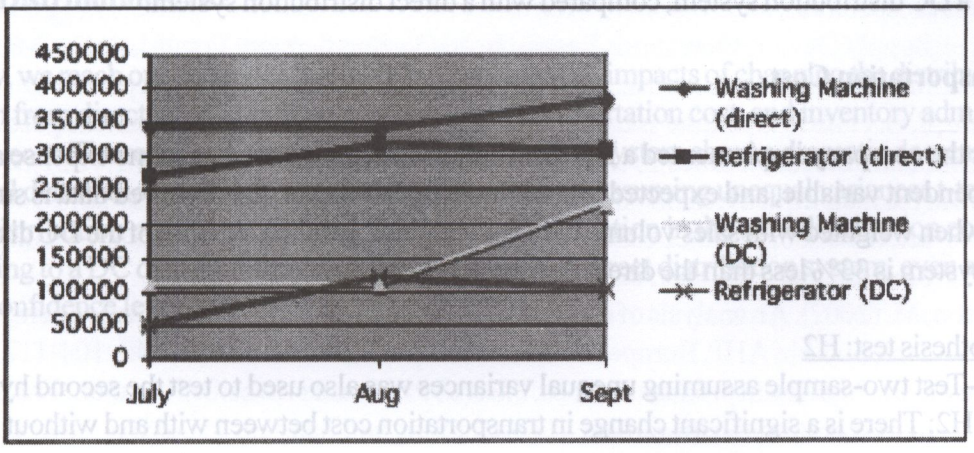
Because of these effects, sales volume in each month was subject to fluctuation. Therefore, this study weighted the data by sales volume to observe the real impact of implementing a DC distribution system.

Averaged Aggregated Inventory Level

Weighted by sales volume, the observed aggregated stock level would be unaffected by the external environment. By changing to a DC distribution system, the company's stock level in July 2009 had dramatically decreased compared with the stock level in July 2009. This is because when the company centralized inventory, there was a large amount of inventory at the warehouse, classed as sunken inventories of each branch, but that does not mean that these sunken inventories cannot be sold in the other branches.

Then, the aggregated stock levels were weighted by sales volume. Figure 3 shows the sales

Figure 3: Comparison of sales weighted averaged aggregated inventory levels



weighted averaged aggregated inventory level of the two products, comparing the old direct system with the new DC system.

We calculated inventory turnover ratio, and inventory turnover ratio days, in order to observe the impacts of changing to a DC system. These ratios are also weighted by sales volume to eliminate the sales volume effects. The result was that for washing machine product, the average turnover ratio per month was 1.863 for the old direct system, and an improved 2.915 for the new DC system. Turnover days reduced from a monthly average of 16.112 days to 10.680 days, showing a quicker turnover of goods under the new DC system. For the refrigerator product, the average monthly turnover ratio increased from 2.219 for the old direct system to 3.103 for the new DC system. Turnover days reduced from a monthly average of 13.833 days to 10.736 days. All this demonstrates that a DC distribution system can increase inventory turnover ratios and reduce inventory turnover days.

The t-test was performed to be confident that the results were significantly improved. The two-sample assuming unequal variances, a comparison between two variables, was used in testing the results of the monthly inventory costs, totaling six observations.

Hypothesis test: H1

The first hypothesis was: H1: There is a significant reduction in averaged aggregated inventory level between with and without distribution center

The Decision Rule is that the confidence significance level is 95%. From the results of the Two-Sample assuming unequal variances, t-test aggregated stock level between direct distribution and a DC distribution system, P (sig. 1-tailed) values of all items are less than 0.05: therefore H1 is accepted. In conclusion, there are significant differences between direct distribution and a DC distribution system at 95% confidence level for all items, which confirms the better performance of inventory management in a DC distribution system. Moreover, at 99% confidence level we also see a significant reduction of averaged aggregated inventory levels from a DC distribution system, compared with a direct distribution system.

Transportation Cost

After the company implemented a DC distribution system, we used gasoline expense as our independent variable, and expected to see it increase. However, the observed data is surprising: when weighted with sales volume the sales weighted gasoline expense of the DC distribution system is 33% less than the direct distribution system.

Hypothesis test: H2

The t-Test two-sample assuming unequal variances was also used to test the second hypothesis: H2: There is a significant change in transportation cost between with and without DC.

From the results of the Two-Sample assuming unequal variances t-test of gasoline expense between direct distribution and DC distribution systems, P (sig. 1-tailed) values of all items are less than 0.05: therefore H2 is accepted.

In conclusion, there are significant differences between direct distribution and DC distribution systems at 95% confidence level. But the significant difference is opposite to that expected, as the DC distribution system reduces gasoline expense significantly compared with the direct distribution system. An explanation of this result may be the clear daily schedule of transportation. Since the company implemented the DC distribution system, the company has set up a master transportation schedule to make an efficient daily transportation schedule. The warehouse and stores know the exact time of delivery. However, at 99% confidence, there is no significant reduction of gasoline expense (0.024>0.01). Hence, at 99% confidence, we reject H2.

Administration Cost

It was expected that there would be extra benefits from suppliers, because the company can save suppliers' costs by delivery to only one place (warehouse) instead of to each store location, or economies of scale in inventory management and administration. However, the result shows that there is no change in either extra benefit from suppliers, or inventory management and administration cost or expense. The company still uses the same number of employees at the same positions, and in the same jobs. Therefore, we have to reject our third hypothesis that: H3: There is a significant change in inventory administration cost between with and without DC

And we reject the hypothesis that there is a change in inventory administration cost between with and without DC. Hence, we conclude that there is no change in inventory management and administration cost.

Total Distribution Cost

Finally, we reach our dependent variable by combining all impacts of changing the distribution system from direct to DC, aggregated stock level, transportation cost, and inventory administration cost. The results of changing to a DC distribution system show a dramatic decrease in the total distribution cost, a 65% reduction. Two-Sample assuming unequal variances t-test of total distribution cost, also confirms the significant reduction in the total distribution cost of changing to a DC distribution system, compared with a direct distribution system, even at the 99% confidence level.

CONCLUSION AND RECOMMENDATIONS

That there was a surprising result, in that there is a reduction in transportation cost by using a DC distribution system. The new clear master transportation schedule may be a reason for this result. However, an overview of changing to a DC distribution system in this short 3-month period sheds light on how the company reduced the total distribution cost. By changing to a DC system, the company can save enough money each month, or 63.55% of the total distribution cost of 2008. These results thus support the company's strategic decision of changing to a DC distribution system.

The following recommendations are made:

1. The company is on the right track in changing from direct to DC system. However, the transportation cost is quite high compared with a direct system. The company should manage the transportation system more efficiently, such as using a bigger truck, setting optimum truck routes, or setting the optimum transportation schedules from the DC to each store and from each store back to the DC.
2. The company should not ignore the development of demand forecasting. An accurate demand forecast can smooth operations, and maintain service levels and competitiveness, particularly in retailers. An accurate demand forecast can also reduce the inventory carrying cost and ordering cost.

In further research, the researcher expects to find the optimum location for the distribution center in order to reduce the logistic cost but still maintain the same customer service level. This further research would include the optimum truck size capacity, optimum route, and optimum schedule.

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