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PERISHABLE FOOD INVENTORY MANAGEMENT: A RETAILER'S PERSPECTIVE

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ABSTRACT

The present work deals with the supply chain problems related to perishable products. The EOQ model has been used to analyze the data collected and suggest a ordering policy that will minimize the loses and maximize the organizational value. The work provides a suggestion for managers to take decision regarding use of self space and reordering of items depending on the inventory usage.

KEYWORDS: Perishable Food Inventory, SCM Processes, EOQ Model, Optimal Order Quantity, Organized Retail. Instantaneous Replenishment, FDI in Multi Brand Retailing

INTRODUCTION

The present work is majorly concerned to solve the supply chain problem and benefit of the various stakeholders involved in the SCM processes. The work tries to maintain the inventory of the organized retailer which would greatly affect the profit in the organized retail sector. Such study was carried on during the time when during the period FDI in multi brand retailing was a hot issue among the various governmental organs and various private players involved. The study is mainly concerned with the managing inventory of the perishable food item which if managed properly will directly reflect in the company's profit in retailing business.

Since inventory in itself is a problem and a solution. The management aspect of inventory is the future of business and the organization that is able to take wise decisions taking into consideration the strategic issues that an organization faces from the immediate environment that the organization is operating from The work that we are presenting here is based on the similar effort and we have taken into consideration the Indian subcontinent condition and its effect on the inventory management. We have tried to narrow down our area of interest for the perishable products so that we can focus more and be closer to it so that we can formulate a function which is more relevant and specific to the chosen item instead of being a general model for a wide variety of items. The various aspects that we have considered here are seasonal availability of the perishable food products and the effect of seasons. We have also taken into consideration the efficient management of shelf space available according to the seasons.

Retail Operation of Perishable Products

Retailers manage the availability of goods with an effective supply chain cycle. The availability of goods whether durable or non- durable depends upon the demand per day at retailer's outlet. Perishable goods/ items come under non-durable goods and their demand per day is non-deterministic in nature. Organized retailers of perishable product are facing challenges to maintain their warehouse/inventory according to right order quantity. Retailers face high challenge to maintain right order quantity with respect to variable demand in order to control inventory. Thus deciding the right order quantity of perishable goods and maintaining the right level of inventory are the key issues that need to be addressed in order to have efficient and responsive retailer supply chain. Perishable items have a limited period of product life cycle which also varies depending upon season. The fruits, vegetables, edible items have set tenure of product life cycle

perishability. The retailers have a main objective to optimize supply chains for perishable items having certain to uncertain demand per day as well as fluctuating prices. Organized retailers have ERP, supply chain management software to visualize per day demand and decide optimal order quantity and optimum cost for multiple periods when demand is probabilistic in nature. Retail store manager may not follow per day ordering of perishable goods decided by an automated inventory replenishment system. The retail operation manager uses orders, shipments and POS data for meeting probabilistic demand generated by automated demand forecasting. Store manager systematically orders the economic order quantity in the peak days to non-peak days depending upon the probabilistic nature of perishable goods.

Perishable products characteristic, product variety, product price, decide the certainty and un-certainty of demand per day. The retailers order quantity of perishable goods depends upon product characteristics, product variety, product price, product demand, self-management, seasonal, unseasonal product items. **Berman and Evans, (2008**) proposed that the supply chain can be optimized to have high profit while providing good service and fresh items to customers at low cost. Thus the overall performance of supply chain is highly affected by the decision making of retailers.

In today's global market, the retailers efficient and responsive supply chain can be achieved only by making timely and accurate decisions regarding ordering quality and maintaining proper inventory in competitive market conditions. The retailers are facing big challenges for maintaining proper inventory of perishable products. **Lian and Liu, (2001)** proposed that perishable items have the uncertain nature of demand, situations are as excess inventory or shortages occur. **Chande et al., (2005)**further explained that if large inventory are maintained, there is maximum chance of spoilage due to deterioration/ decay of perishable products, which can only be discarded after expiry items. On the contrary if lesser inventory is maintained of perishable items, there are chances of shortage when demand exceeds inventory.

This leads to cost of penalty incurred due to decreased future demand resulting from loss of number of loyal customers. Therefore, retailers face problem as a challenge while maintaining proper inventory and ensuring optimal order quantity with respect to time. Since, the demand is to stochastic in nature, retailers face problem to decide the exact ordering quantity depending up seasonal products or the exact level of inventory so that cost can be maximized. **Chang (2009)** developed a model and an algorithm to find the optimal order quantity strategy for retailers to maximize the average profit per unit time. **Srimirara Rao et al (2007)** developed and analyzed an inventory model for a commodity with random life time which was based on pareto distribution. **Chi Chiang (2006)** proposed optimal ordering policies by considering a periodic review inventory model with replenishment cycles by using dynamics programming.

Chande et al (2005) proposed a method for determining the optimal time for predicting price, promotion and optimal ordering quantity in each period for a perishable item over a finite horizon. **Nahmias et al (2004)** considered a situation wherein inputs as well as demands are random in nature and proposed a queuing based perishable inventory model **Chun (2003)** proposed an optimal ordering policy and 4optimal pricing model for perishable product. **Ravichandran (1995); Giri and Chaudhuri (1998); Liu and Lian (1999)**Have given unconstrained nonlinear system can be modeled by using the equation on the inventory level over time by using this equation we can obtain the inventory carrying cost the fixed ordering cost, the purchasing cost, the shortage cost, and the salvage cost. If the total relevant cost function is continuous and second-order differentiable over the decision variable of the current system (in most cases, the ordering quantity or reorder level), then we can obtain the first-order stationary point as the optimum. **Dell, (1999)** the push or pull decision which is most affected by the three variables out of five effecting the make to order decision or make to stock decisions. Pull decisions are linked to obsolescence and delivery time. The former because firms do not desire to maintain excess inventory of finished goods that are at risk of becoming obsolete. **Leeuw et.al; (1999)** Look at products markets and processes as determinants of distributed control techniques such as centralization of inventory and reorder

planning. **Adachi et al. (1999)** proposed a perishable inventory model using the theory of Markov decision process, with a focus on different selling prices of perishable commodities under stochastic demand to determine an optimal inventory policy that maximizes expected average profit per period. They considered discriminating selling prices by different lifetimes.

The present work is done to provide organized retailers a insight in to the real time manage management of the inventory so that the decision making regarding the perishable inventory can be done so that wastage be minimized and profit be maximized. The present work will be done on empirical analysis done on thee retailers. The present work is based on the EOQ model to analyze the data collected the work based on EOQ model has been done by **Papachristos and Skouri (2003)** presented an inventory model for determining items where demand rate is a convex decreasing function of the selling price. **Khanra and Choudhry (2003)** developed an EOQ model with shortages over a finite-time horizon, assuming a quadratic pattern **Park** and **Hollier** and **Mak (2006)** also considered constant backlogging rates in their inventory models. In some inventory model however, such as fashionable commodities, the length of the waiting time for next replenishment is the main determining whether the backlogging will be accepted or not.

He proposed an EOQ model that allows for shortage during this time the backlogging rate was assumed to be reliable and was dependent on the duration of the waiting time ink inventory model the demand function is exponentially decreasing and backlogging rate is inversely proportional to the waiting time for the next replenishment. **Chung et al. (2007), Goswami et al. (1995), Goyal et al. (2001), Pal et al. (1993), Raafat (1991), Wee et al. (2001) and Skouri et al. (2007)** proposed the EOQ model making assumptions about the value of the money at that present time, demand rate that is variable, the rate of deterioration, the shortages existing in inventory with a constant or probabilistic number or an exponential function considered demand as a function that is constant for instant model that is based on deterioration and perish ability**.**

Sana and Chaudhuri (2008) presented an EOQ with delay in payments and price discount offers. **Jaber et al. (2008)** proposed an analogy between the behavior of production system and the behavior of physical systems. The main purpose of this research is to introduce the concept of entropy cost to account for hidden costs such as the additional managerial cost that is needed to control the improvement process.

METHODOLOGY

The solution to the research problem consist of two parts one is to formulate a demand function which can efficiently manage the inventory of the perishable items and other is use of demand function to help managers in organized retail to have a better inventory management system. The model so developed and its outputs would be evaluated using the EOQ model

RESEARCH OBJECTIVE

- To formulate the optimal order quantity method for retailers of perishable products with non-deterministic demand in organized retail.
- To analyze the best method for optimizing retail operation in organized retail.

The method of data collection was the primary data which was backed by the secondary data as well. The focus group interviewing technique was used for the data collection. The questionnaire which was filled with various retailers which dealt with the perishable food items.

Structured surveys were used to answer the questions which were related to the various methods used for ordering the items in inventory by the retailer..Non probability sampling method was used with random collection of data from the retailers. The Research study is focused on Retailers who sell perishable items like fruits, vegetables, meat, frozen items and bakery products. The primary data were collected through face-to face interviews with the retailers who sell fruits, vegetables and bakery products. The data presented in the research study belongs to the year 2012.

The demographic data on the retailers reorder quantity of perishable products have been collected from the Uttar Pradesh region and some part of New Delhi. The questionnaires were used to take the response from retailers is a structured manner. The data collection method used was a questionnaire and the technique used was face-to face interview. The study focuses on finding out whether there is a significant relationship between levels of importance attached to certain perishable products.

220 questionnaires were sent to respondents. A total of 200 responses was received and 20 questionnaires were not included due to missing values. There were 200 valid questionnaire with a 200*100/220=90%.The primary data that was collected through the survey was compared through statistical analysis.

Model Test

The SPSS was used to examine the hypothesis. The variance of the dependent variable can be explained by using the independent variable and the result is quite significant ($P<0.001$).

In processing retailer's data, descriptive statistics and Linear regression models, inter-item correlation matrix analysis was applied. The Linear regression, correlation analysis is widely used in retail research, as they have a wide array of applications and hypothesis. These analyses are flexible enough for applications and even data measured by weak scales.

Analysis of Relationship between Replenishment Time as Dependent Factor and Perish Ability as Independent Factor

H0: The perish ability of items is not positively related to replenishment time.

H1: The perish ability of items is positively related to replenishment time.

Table 1: Item Statistics

Replenishment Time (Cronbach's Alpha) =0. 73	Mean	Std. Deviation	N
Replenishment time-fruit	1.21	0.405	200
Replenishment time-vegetable	1.07	0.247	200
Replenishment time-frozen	2.12	0.326	200
Replenishment time-milk	1.00	0.000	200
Replenishment time-meat	1.76	0.431	200
Replenishment time-juice	2.00	0.000	200
Replenishment time-ice-cream	2.00	0.000	200
Replenishment time-bakery	1.00	0.000	200
Instantaneous replenishment	1.07	0.309	200
Valid N (listwise)			**200**

The reliability coefficients of all the psychometric scales are used as shown in Table 1. With respect to predictor of replenishment time, the Cronbach's alpha coefficient of variables ranged from 0.69 to 0.73 (Coefficient 0.6 and above). The alpha reliability indicates high internal consistency of all three predictors, with α=0. 69 on shelf space, α=0. 72 on Perishability. These scores are accepted according to Nunnally (1967)

Table 2: Item Statistics

Shelf Space (Cronbach's Alpha) =0. 69	Mean	Std. Deviation	N
Shelf space-fruit	3.04	0.232	200
shelf space-vegetable	3.90	0.301	200
shelf space-frozen	1.88	0.346	200
shelf space-milk	1.00	0.000	200
shelf space-meat	1.00	0.000	200
shelf space-juice	1.07	0.247	200
shelf space-ice-cream	1.03	0.171	200
shelf space-bakery	1.05	0.218	200
Shelf space allocation adoption	1.09	0.372	200

The Item statistics in table 2 provides the mean scores, SD results. The SD for each of the scores indicates the respondents' views varied considerably across the sample. The mean score and SD indicates that respondents agreed that the retail organization provide replenishment time on the basis of perish ability and shelf space of items.

Respondents perceived that the replenishment time for fruit (mean=1.21, SD=0.405)

Respondents perceived that the replenishment time for vegetable (mean=2.12, SD=0.326)

Respondents perceived that the replenishment time for milk (mean=1. 00, SD=0. 000)

Respondents perceived that the replenishment time for meat (mean=1. 76, SD=0. 431)

Respondents perceived that the replenishment time for juice (mean=2. 00, SD=0. 000)

Respondents perceived that the replenishment time for ice-cream (mean=2. 00, SD=0. 000)

Respondents perceived that the replenishment time for bakery (mean=1. 00, SD=0. 000

Table 3: Item Statistics

Perishability (Cronbach's Alpha) =0. 72	Mean	Std. Deviation	N
Perishability	2.53	0.750	200
Freshness	2.04	0.829	200
Physical state	3.19	1.130	200
Demand rate	3.47	1.061	200
Past demand	2.05	0.735	200
Price	2.25	0.663	200
Inventory	2.80	1.131	200
%of product not sold	49.05	8.774	200
sold at discounted price	31.83	9.272	200
% of products that are wasted	18.23	5.779	200
Unit cost of perishable as compared to non perishable	1.07	0.247	200

The reliability coefficients as shown in Table 3 of all the psychometric scales are used. With respect to the predictor of shelf space allocation and perish ability scales, the Cronbach's alpha coefficient of variation ranged from 0.69to 0.72 (Coefficient 0.6 and above).

The alpha reliability indicates high internal consistency of all three predictors, with α=0. 69 on shelf space allocation, α=0. 72 on perish ability. These scores are accepted according to Nunnally (1967).

Analysis of Relationship between Perishability and Demand Rate on the Basis of Physical State and, Freshness

H0: demand rate is not positively related to Perishability on the basis freshness.

H1: demand rate is positively related to Perishability on the basis freshness.

Table 4: Inter-Item Correlation Matrix

	Perish-ability	Fresh-ness	Physical State	Demand Rate	Pastde-mand	Price	Inventory
Perishability	0.000						
Freshness	0.776	0.000					
Physical state	0.912	0.807	0.000				
Demand rate	0.952	0.221	0.048	0.000			
Past demand	0.059	0.601	0.397	0.721	0.000		
Price	0.395	0.217	0.259	0.940	0.556	.000	
Inventory	0.633	0.450	0.690	0.516	0.825	.804	0.000

All the correlations are significant at the 0.01 level. As from the Table 4.2.1 the result is presented in inter-item Correlation Matrix shows that perish ability (r=0. 804), is significantly related to demand rate. Thus null hypothesis is rejected and alternate hypothesis is accepted. (According to Connolly and Sluckin, 1962 the r-value 0.90-1.00 shows the positive and strong relationship, 0.70-0.90 shows the good relationship, 0.40-0.70 shows the moderate relationship, 0.20-0.40 shows the low relationship and the value less than 0.20 shows the weak relationship.)

All of the variables in this study were found to be significantly positive correlated. Inter-item correlation is used to examine possible relationships between demand rates and perishability. The inter-item correlation matrix reveals a statistically significant correlation is found (r=0. 804, p<0.01) Linear regression analysis was used to determine whether the linear combination of demand rate and perish ability show significant positive correlation.

For all these demand rates mentioned independent variables show statistically significant positive correlation. Demand rate (r2=0. 952, p<. 01), past demand (r^2 =0. 59, p<. 01), price (r^2 =0. 395, p<. 01), inventory (r^2 =0. 633, p<. 01), freshness (r^2 =0. 766, p<0.01) and physical state (r^2 =0. 912, p<0.01). The inter-item correlation matrix shows a strong relationship between freshness and perishability.

- Physical state is positively and strongly related to the perishability. More good the physical state, less chances of early deterioration.
- Freshness also hugely depends upon the physical state good physical state promises more freshness to customer.

Demand rate is strongly related to the perishability whereas low relationship between freshness and physical state. Past demand is having a good relationship with demand rate which also is equal for freshness as well. Price and demand rate are highly correlated so the price can affect the demand significantly. Inventory relationship is strong with past demand and price whereas freshness and demand rate is having a moderate relationship. So the retailer's policy should so be designed that the past demand forms a major part of inventory management and moreover such measures should be taken so that physical state and freshness is maintained for a longer period of time as it directly affects the demand of the items.

Analysis of Relationship between Replenishment Time and Instantaneous Replenishment

H0: Replenishment time is not positively related to instantaneous replenishment.

H1: Replenishment time is positively related to instantaneous replenishment.

All the correlations are significant at the 0.01 level. As the table 4.3.1 shows, the result is presented in inter-item Correlation Matrix shows that replenishment time (r=0.856), are significantly related to instantaneous replenishment

Table 5: Inter-Item Correlation Matrix

	Replenishment Time-Fruit	Replenishment Time-Vegetable	Replenishment Time-Frozen	Replenishment Time-Milk	Replenishment Time-Meat	Replenishment Time-Juice	Replenishment Time-Ice	Replenishment Time-Bakery	Instantaneous Replenishment
Replenishment time-fruit	0.000								
Replenishment time-vegetable	0.928	0.000							
Replenishment time-frozen	0.866	0.969	0.000						
Replenishment time-milk	0.503	0.606	0.492	0.000					
Replenishment time-meat	0.725	0.166	0.000	0.288	0.000				
Replenishment time-juice	0.610	0.675	0.899	0.142	0.830	0.000			
Replenishment time-ice-cream	0.610	0.775	0.889	0.142	0.720	0.000	0.000		
Replenishment time-bakery	0.803	0.606	0.492	0.000	0.788	0.642	0.742	0.000	
Instantaneous replenishment	0.681	0.745	0.125	0.472	0.688	.0856	0.856	0.672	0.000

Thus null hypothesis is rejected and alternate hypothesis is accepted. (According to Connolly and Sluckin, 1962 the r value 0.90-1.00 shows the positive and strong relationship, 0.70-0.90 shows the good relationship, 0.40-0.70 shows the moderate relationship, 0.20-0.40 shows the low relationship and the value less than 0.20 shows the weak relationship.)

All of the variables in this study were found to be significantly positive correlated. Inter-item correlation is used to examine possible relationships between replenishment time and instantaneous replenishment. The inter-item correlation matrix reveals a statistically significant correlation is found (r=0. 856, p<0.01) Linear regression analysis was used to determine whether the linear combination of replenishment time and instantaneous replenishments how significant positive correlation.

For all these instantaneous replenishment mentioned independent variables show statistically significant positive correlation. Replenishment time-vegetable (r2=0. 928, p<. 01), Replenishment time-frozen (r^2 =0. 866, p<. 01), Replenishment time-milk (r^2 =0. 503, p<. 01), Replenishment time-meat (r^2 =0. 725, p<. 01), Replenishment time-juice (r^2 =0. 610, p<. 01) and Replenishment time-ice-cream (r^2 =0. 610, p<. 01) and Replenishment time-bakery (r^2 =0. 803, p<. 01Replenishment for vegetable is very less so it needs an instantaneous replenishment.

Replenishment time of fruit and meat are nearly the same and less than the vegetables so need to be replaced on a daily basis. Replenishment time for frozen and its instantaneous replenishment shows less correlation so can be replaced on a weekly basis.

Replenishment time for juice and ice-cream had a strong correlation with instantaneous replacement but this is not in relation to the perishability but as these are more demanding so are instantaneously replaced. Instantaneous replacement of frozen items is less as they are less demanding and less perishable. Bakery products have moderate level of instantaneous replacement i.e. need replacement every third day on an average.

RESULTS AND CONCLUSIONS

The analysis reveals that perishability influences replenishment time rates. The findings on the basis of mean value and standard deviation the interpretation for fruit replenishment time rate is per day to balance demand, vegetables replenishment time rate is per day to balance demand, frozen replenishment time rate is per weekly to balance demand, meat replenishment time rate is per day to balance demand, milk replenishment time rate is per day to balance demand, bakery replenishment time rate is per day to balance demand.

The inter-item correlation matrix in Table 1 shows a strong relationship between freshness and perishability.

- Physical state is positively and strongly related to the perishability. More good the physical state, less chances of early deterioration.
- Freshness also hugely depends upon the physical state good physical state promises more freshness to customer.

Demand rate is strongly related to the perishability whereas low relationship between freshness and physical state. Past demand is having a good relationship with demand rate which also is equal for freshness as well. Price and demand rate are highly correlated so the price can affect the demand significantly. Inventory relationship is strong with past demand and price whereas freshness and demand rate is having a moderate relationship.

So the retailer's policy should so be designed that the past demand forms a major part of inventory management and moreover such measures should be taken so that physical state and freshness is maintained for longer period of time as it directly affects the demand of the items. Replenishment for vegetable is very less so it needs an instantaneous replenishment.

Replenishment time of fruit and meat are nearly the same and less than the vegetables so need to be replaced on daily basis. Replenishment time for frozen and its instantaneous replenishment shows less correlation so can be replaced on weekly basis. Skimming pricing should be adopted by the retailers when the product is fresh and the discount should be later on

Future Scope

Further work can be scaled up to n number of items by collecting more accurate and reliable data regarding the usable period. Moreover due to limitation of time and resources the research was limited to the northern part of the country; in future the research can be carried for more spread geographical locations.

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