Policies on the inventory performance finance essay

Finance

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Certificate

This is to certify that the project titled " An Evaluation of Inventory Policies on the Inventory Performance of a Retail Store" carried out by Priti Kumari (Roll No. F-126) is a bona fide work submitted in partial fulfilment of the requirements for the award of the degree of Master of Business Administration. Dr. Debadyuti Das Priti KumariProject Guide MBA (FT), 2011-2013Faculty of Management Studies Faculty of Management StudiesUniversity of Delhi University of Delhi

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Executive Summary

In this report, the case of a particular item in a retail store selling various grocery items is studied and a (R, S) inventory replenishment policy is proposed and evaluated by means of discrete event simulation. The complexity of this single item inventory problem requires a fast and reliable method of determining the operating conditions that optimize the inventory control. Simulation techniques can be effectively used to determine an

adequate ordering policy for this type of problems. Several ordering options were analyzed and compared to find the policy that best accomplishes the firm’s organizational objectives. The simulation model built allows the dynamic change in the demand pattern for each day of the item. The results revealed that the implementation of the replenishment policy can reduce total investment and maximize customer service, while maintaining the business efficiency. Various Literature review have been carried out in order to gain knowledge about various inventory management techniques, replenishment policies, various myths related to inventory management, methods of inventory monitoring and measurement and how to use inventory management to gain competitive advantage. In this study a small value item noodles have been taken for inventory measurement purposes. Suitable assumptions have been made in order to rum the simulation model. Further in this report, we have developed simulation model for different review periods and different order upto level, for uniformly distributed lead time and normally distributed demand. Various measures of inventory performance have been taken into account like average inventory, inventory level, backorder, fill rate etc. And in terms of costs Inventory carrying cost, backordering cost, ordering cost have been considered. Then analysis has been done on the basis of results that we have got through simulations and based on our analysis of these results we have concluded about what the best model of replenishment policy is for different types of retailers.

Introduction

Inventories constitute an important investment in all type of firms, from a merchandise distributor to a manufacturer of products. Huge quantities of

materials are sometimes kept on stock to deal with productive constraints or to fulfil dynamic demand patterns. In this sense, it is vital to have effective information to aid the management for the decision making process to maximize the customer service, minimize total investment and maintain the operating efficiency. The situation turns complex because these objectives are in conflict with each other, and tradeoffs occur when trying to improve one of them. For example, to maximize customer service, a relatively high investment in inventories is required, and due to capital constraints, these funds could have the opportunity of better profit in some other investment. The conflict finds its solution when applying an efficient inventory control, levelling these tradeoffs between investment and costs to find an adequate policy for the operation of the business. This principle is well known and simple in concept; however the complexity of real situations makes it difficult to apply. Most of the real situations not only face a one item problem, but multiple items with several periods of replenishment. These inventories are frequently managed in aggregate due to the complexity of handling each individual item. Managing assets of all kinds can be viewed as an inventory problem, for the same principles apply to cash and fixed assets as to inventories themselves. Traditionally, the academic literature on inventory focuses on production and procurement as the principal determinants of corporate inventory policy and management. In this sense, the trade-off between ordering costs and holding costs characterizes the transactions approach to inventory management represented by the EOQ and (S, s) models of inventory developed many decades ago. In recent times, more management-oriented topics include the material requirements planning

systems (MRP), just-in-time (JIT) and ERP methods while another emerging stream of studies postulates that the characteristics of a firm's demand and marketing environments also play an important role in determining optimal corporate inventories. Notwithstanding the theoretical or practical shortcomings inherent in these concepts and techniques, their application in real business life should have an effect in firms' performance. Our Purpose in the present paper is to investigate the relationship (if any) between inventory replenishment policies and inventory performance of a retail store. In general, efficient or inefficient management of inventories is only one factor that may influence firm performance. A range of other macroeconomic, industry and firm-level factors are also important. Nearly all the literature on optimal inventory management uses criteria of cost minimization or profit maximization. An inventory managers' goal for example, is modelled as minimizing cost or maximizing profit while satisfying customers' demands. If inventory decisions do not affect the revenue stream, these two criteria result in the same optimal replenishment policy. In the operations management literature the question of how much inventory a firm should keep has been extensively studied but there is dichotomy in the views given that inventory is both an asset and a liability. Too much inventory consumes physical space, creates a financial burden, and increases the possibility of damage, spoilage and loss. Further, excessive inventory frequently compensates for sloppy and inefficient management, poor forecasting, haphazard scheduling, and inadequate attention to process and procedures. On the other hand, too little inventory often disrupts manufacturing operations, and increases the likelihood of poor customer

service. In many cases good customers may become irate and take their business elsewhere if the desired product is not immediately available. Empirical evidence in the inventory replenishment-performance relationship produced also mixed results. And so the Inventory replenishment policies have to be decided to evaluate inventory performance. Given that the results from few empirical studies on the microeconomic determinants and consequences of inventories are somewhat contradictory; our study will try to shed more light to this issue by employing simulation models. Objective of our research work is to identify an order upto level and a review period which would minimize the inventory carrying cost, ordering cost and backordering cost and at the same time will try to maximize the fill rate. Further in this report, we have developed simulation model for different review periods and different order upto level, for uniformly distributed lead time and normally distributed demand. Various measures of inventory performance have been taken into account like average inventory, inventory level, backorder, fill rate etc. And in terms of costs Inventory carrying cost, backordering cost, ordering cost have been considered. A small value item, noodles have been taken into consideration for measurement of inventory performance and costs associated with it. The rest of the dissertation is organized as follows. The second Chapter constructs literature review of various existing literatures on the topics which provides us the motivation for this particular research. Chapter 3 lists the Research Methodology which includes development of simulation model. Chapter 4 gives the data source and analysis of results which is followed by Chapter-5 which provides concluding remarks, limitation and recommendations.

Literature Review

2. 1 A Study on Inventory Replenishment Policies in a Two-echelon Supply Chain System

By: H. T. Lee a,*, J. C. Wu b (Computers & Industrial Engineering 51 (2006) 257–263, Science Direct)Inventory control plays an important role in supply chain management. Properly controlled inventory can satisfy customers' demands, smooth the production plans, and reduce the operation costs; yet failing to budget the inventory expenses may lead to serious consequences. The bullwhip effect, observed in many supply chain management cases, causes excessive inventory due to information distortion, i. e. the order amount is exaggerated while a minor demand variation occurs, and the information amplified dramatically as the supply chain moves to the upstream. In this paper, one of the main causes of bullwhip effect, order batching, is considered. A simplified two-echelon supply chain system, with one supplier and one retailer that can choose different replenishment policies, is used as a demonstration. Two types of inventory replenishment methods are considered: the traditional methods (the event-triggered and the time-triggered ordering policies), and the statistical process control (SPC) based replenishment method. The results show that the latter outperforms the traditional method in the categories of inventory variation, and in the number of backlog when the fill-rate of the prior model is set to be 99%. This research provides a different approach to inventory cost-down other than the common methods like: information sharing, order batch cutting, and lead time reduction. By choosing a suitable replenishment policy, the number of backorder and the cost of inventory can be reduced. This research aims at a

different approach. The authors would like to develop a straightforward method for supply chain members to choose as their replenishment policy in a dynamic environment. A simplified two echelon supply chain system with one supplier and one retailer is used to demonstrate the policy-chosen behaviours. The order batching problem in supply chain from Lee et al. (1997a, 1997b) is studied. Two inventory replenishment methods, the traditional event- and time-triggered methods and the statistical process control based replenishment method, are considered and compared. Practical suggestions for inventory management are given based on a lower inventory level to both of the upstream and the lower stream of supply chain. Pull inventory systems usually appear in two extreme cases. The first one is the globalized entrepreneurs whose regional executives have to take actions on balancing high commodity setup and local stock costs. With an affluence of information, managing inventory is still a complicated decision to make. The other extreme is in variety shops where owners have to manage the inventory based on their past experiences. In both cases, managers rely on experiences, forecast techniques, or historical data in order to gain economical settings. This research concentrates on replenishment suggestions based on the sense of cutting the inventory expenses throughout the entire supply chain by reducing inventory variations.

Supply Chain Modelling

The most common inventory replenish policies are considered: the lot size-reorder point order-quantity (s, Q), and periodic review order-up-to (R, S) systems. A single product echelon unit (one supplier and one vendor) is used

for demonstration purposes. The modified SPC-based inventory management method introduced in the prior section is adopted.

Conclusion

Companies tend to order in batches to gain economical advantages ever since the awareness of inventory control. The order batching problem causes bullwhip effect in supply chains and increases the operation costs substantially. This paper focuses on reducing the bullwhip effect caused by order batching. Inventory managers can reduce the inventory cost by properly choosing replenishment methods without many calculation tasks. Although the conclusion is drawn from a simplified supply chain framework, the idea of altering replenishment policies can be applied to other cases of decentralized supply chains. The numerical example shows that the SPC-based inventory control techniques, which monitor the demand and inventory on an ongoing basis, can adjust replenish quantity dynamically.

2. 2 The Effect of Inventory Management on Firm Performance

By: Dimitrios P. Koumanakos (International Journal of Productivity and Performance Management, Emerald Article)Managing assets of all kinds can be viewed as an inventory problem, for the same principles apply to cash and fixed assets as to inventories themselves. Traditionally, the academic literature on inventory focuses on production and procurement as the principal determinants of corporate inventory policy and management. In this sense, the trade-off between ordering costs and holding costs characterizes the transactions approach to inventory management represented by the EOQ and (S, s) models of inventory developed many

decades ago. In recent years, as the field of operations management has developed, many new concepts have been added to the list of relevant inventory control topics. These more management-oriented topics include the material requirements planning systems (MRP), just-in-time (JIT) and ERP methods while another emerging stream of studies postulates that the characteristics of a firm's demand and marketing environments also play an important role in determining optimal corporate inventories. Notwithstanding the theoretical or practical shortcomings inherent in these concepts and techniques, their application in real business life should have an effect in firms' performance. Their purpose in the present paper was to investigate the relationship between inventory management practices and company performance. Inventory turnover ratio served as their proxy for the implementation of inventory management practices whereas two profitability accounting ratios will be interchangeably used for the evaluation of corporate performance. In general, efficient or inefficient management of inventories is only one factor that may influence firm performance. A range of other macroeconomic, industry and firm-level factors are also important. Historically, economists have focused on industry level variables using the structure- conduct-performance (SCP) framework. This stresses the role of industry concentration and a firm's market share, since higher levels of both could be (theoretically) linked to higher profitability. Empirical studies also investigate other possible determinants, for example, ownership structure of the firm, strategic direction size of board innovation etc. In this study however, in an attempt to isolate the impact of inventory policies they did not consider other possible predictors of performance. Nearly all the

literature on optimal inventory management uses criteria of cost minimization or profit maximization. An inventory managers' goal for example, is modelled as minimizing cost or maximizing profit while satisfying customers' demands. If inventory decisions do not affect the revenue stream, these two criteria result in the same optimal replenishment policy.

Empirical results

In order to investigate the impact of inventories management on corporate profitability it successively applied the ordinary least squares (OLS) procedure by year and industry. Their goal was to address the micro level relationship between inventory optimization strategy and performance, while isolating macro industry level influences. Therefore, they restricted their analysis to one industry each time and as a consequence, the results obtained are less noisy while performance gains and losses can be more plausibly linked to the strategy of inventory policy.

Conclusion

The purpose of this study was the investigation of existence of a possible linear relationship between inventory holdings and accounting based measures of performance for a recent group of Greek manufacturing firms belonging to the food, textiles and chemicals sectors. Results verified by the PLRT confirm the existence of a robust linear relationship but only in the sector of chemicals. Therefore, another parametric or a non-parametric model is needed to describe this relationship in the other sectors. Research is based on firm-specific financial data; it has certain limitations that can be addressed in future research using more detailed data sets. In this context,

given the great number of the possible determinants of performance it is difficult to isolate the effect of inventories even by using large samples and advanced methodologies. Thus a major issue of concern is that of omitted variables. Another limitation is the questionable validity of the accounting data used after the results presented by two recent international studies the only two among others which include Greece in their sample. Both studies conclude that earnings management is more pronounced in Greece than in other countries.

2. 3 Using Inventory for Competitive Advantage through Supply Chain Management

By: Thomas C. Jones, Daniel W. Riley (International Journal of Physical Distribution & Logistics Management, Emerald Article)Competitive pressures will force major changes in inventory management in the next few years. Changes will result from businesses identifying and capitalising on the opportunities to manage their entire supply chains as single entities. Supply chain management techniques deal with the planning and control of total materials flow from suppliers through end-users. These techniques will probably destroy many of the myths of the past. This article covers four areas:• Inventory myths versus realities;• How to gain competitive advantage through supply chain management;• Case studies of supply chain techniques;• Barriers to a supply chain approach.

Inventory Myths versus Realities

Some new, some as old as business inventory myths are; Myth 1: " Sophisticated techniques and organisational discipline will provide more accurate sales forecasts." Myth 2: " Japanese techniques, such as Just-In-

Time, will all but eliminate inventory problems." Myth 3: " Inventory provides the necessary buffer to protect manufacturing from seasonal and business cycle variations." Myth 4: " Local presence is a key element of our service — you can't sell from an empty wagon." Myth 5: " Distributors, as independent businessmen, provide local availability and entrepreneurial inventory management." Myth 6: " Local dealers need to be backed up by readily available regional stocks." Myth 7: " Modern information systems and control methods will all but eliminate obsolete and slow-moving inventories."

How to Gain Competitive Advantage through Supply Chain Management

Supply chain management deals with the total flow of materials from suppliers through end-users. The key to efficiently managing a supply chain is to plan and control the inventories and activities as an integrated single entity. Three elements must come together for integrating the supply chain to operate effectively:— Recognising end-user customer service level requirements;— Defining where to position inventories along the supply chain, and how much to stock at each point;— Developing the appropriate policies and procedures for managing the supply chain as a single entity. In today's markets, inventory and distribution must satisfy key customer needs of time and place utility (item availability, delivery response time). Customers place value on their service needs and frequently these needs vary substantially from segment to segment and even customer to customer. Further, a supply chain will utilise increasing amounts of resources to satisfy higher service levels and customer needs. These resources comprise inventory, transportation expense, facilities and people. The objective of

integrating the supply chain is to lower the total amount of resources required to provide the necessary level of customer service to a specific segment. The second step in integrating the supply chain is to consider and evaluate alternative inventory stocking points along the supply chain which will provide acceptable customer service without unfavourably impacting overall cost-to-serve. This evaluation must also deal with the impact on manufacturing costs and efficiencies. A final step in supply chain integration is to develop and install the necessary policies, organisational relationships, systems, and controls to manage the supply chain as a whole.

Barriers to a Supply Chain

The barriers to a supply chain approach are tradition, organisational, legal and non integrated management systems. Traditionally, supply chains of necessity have been managed and controlled functionally. For those portions of the supply chain that are captive to the manufacturer, there are usually strong organisational boundaries between activities, e. g., procurement and manufacturing, manufacturing and production control, manufacturing and distribution management, etc. The management objectives and measures for each of these functions are in fundamental conflict. Independent businesses, vendors, and distributors add obvious barriers. Establishing mutually advantageous relationships to make the chain work more smoothly and at lower costs is the key. The tools available to work with are volume, price, commitment horizon, schedule stability, and exclusivity of franchise. Finally, information and control systems are often barriers. These have usually been developed for each functional area on a piecemeal basis. Lack of integration across the supply chain often precludes the visibility and timeliness required

for managing the chain as a single entity. The analytical tools necessary to analyse and control complex and often multinational supply chains are now available. It is clear that the use of these tools can provide firms with the opportunity to use their inventory and distribution systems to gain competitive advantage in the market segments they serve.

2. 4 Methods of Inventory Monitoring and Measurement

R. L. Ballard (Logistics Information Management, Emerald Article)Inventory control is seen as the management function – forecasting, determining requirements, setting targets and issuing instructions – whereas the monitoring of stocks in the warehouse is seen as a supervisory function requiring less skill and experience. The purpose of inventory monitoring and measurement should be to provide management with the information to improve operations and reduce errors.

Inventory in the warehouse

Inventory is generally considered to comprise three main areas:(1) Raw materials and components(2) Work in progress(3) Finished goodsWhere these are held and in what quantities, and how they are managed will vary significantly from one organization to another. In some organizations all three will be held in a store at some time, whereas in others, raw materials may arrive just in time and finished work in progress will be held only alongside the production line. Inventory has to be monitored wherever it is held; in this paper consideration is given only to the monitoring and measurement of those goods within the warehouse environment. Monitoring

and measurement is considered as a part of the overall process of warehouse management.

What has to be monitored and measured?

Here stock information is split broadly into three main categories;(1) Fixed information. This describes those aspects of a stock keeping unit (SKU) which will not change or will not change often. These include:• Product code;• Description;• Batch number or similar (if appropriate);• Size;• Weight;• Storage/handling type (e. g. pallet, tote, carton);• Minimum pick quantity;• Picking priority (e. g. FIFO);• Preferred store area or zone;• Secondary store area or zone.(2) Variable information. This describes those aspects which will be highly dynamic and which may change frequently during a working day. These are associated with the warehouse process and include:• Unique identity of each unit load in stock (e. g. pallet number);• Location of each unit load;• Quantity of SKUs in each location;• Movement of each picked item;• Load status (e. g. available, quarantine, QC hold).(3) Derived information. This is information which can be determined by analysis of the fixed and variable information. It will vary from organization to organization, depending on management requirements, but is likely to include:• Movement rate per SKU (i. e. analysis of fast, medium and slow movers);• Stock discrepancies (compared with master record in inventory control system);• Space utilization in the store;• Operator productivity.

Cycle counting

With the method of cycle counting, a selected number of items are counted every day. Counting can be by SKU which allows the frequency of counting to

be based on the movement rate. Alternatively counting can be by location, which is arguably more accurate. Records are maintained to ensure that all items will be checked at least once per year. Any discrepancies are immediately dealt with and adjustments made as appropriate.

Residual balance counting

Residual balance counting can be made to work particularly well if a " real time" warehouse management system. The number reported is compared with the master stock record and if discrepancies are found, appropriate action can be taken immediately. A record is maintained of the locations visited and systems are maintained to count, at regular intervals.

How do we gather the information?

For all but the smallest of organizations, the task can only be performed satisfactorily with some form of computerization. The more comprehensive the computer system, the more it becomes possible to automate the monitoring and measuring of the warehouse process, and the more readily information becomes available.

Conclusions

Inventory monitoring and measurement is vital for the successful operation of a modern warehouse. It is an essential part of an organization’s management information system.• Inventory monitoring and measurement is not the same as inventory control.• Inventory monitoring and measurement is much more than stock checking.• Inventory monitoring and measurement is concerned with warehouse management and knowing all about the stock in the warehouse in terms of location and time.• Good

systems monitor the process to identify errors as they arise. Good systems are not primarily concerned with recording historic data.• Information needs to be up to date. The more quickly changes can be monitored; the more accurate will be the measurement of the warehouse performance.• Rapid update of information will help minimize errors and improve effectiveness.• Some form of computerization, over and above the inventory control system, is highly desirable and the higher the level of computerization the more the monitoring and measurement process can be automated.• Most benefits will come from the implementation of a computerized warehouse management system with data transfer facilities to other parts of the management information system, including the inventory control system.• If the existing system is limited concentrate on knowing about the fast moving products and looking for the source of errors. Make sure procedural disciplines are imposed and deal with the problems one by one

2. 5 Inventory policy for dense retail outlets

By: Michael Ketzenberg a, Richard Metters b, Vicente Vargas c (Journal of Operations Management 18_2000. 303–316)In recent years, a number of retail firms have made plans to adopt a ‘‘ denser’’ store strategy. Here the term ‘‘ density’’ is used to refer to the number of products or categories that a store provides per unit of selling space. This desire has taken two different forms. For some, there has been an increase in the number of product categories or individual stock- keeping units (SKUs). within the same sized store. For others, there has been a desire to reduce store size. The theory behind increasing category and product variety is that high variety stores are more attractive to customers as they offer a better opportunity for one-stop

shopping. Largely, the grocery industry has accommodated increases in SKUs by increasing store size, as average store size has increased nearly 50% from 1985 to 1994. However, large stores have several disadvantages well known to retailers: a strategy of a few large stores versus several smaller stores leaves customers with more travel time required to get to a store, usually mean more difficulty in parking an automobile close to a store, and requires more search time for customers within a store. Leaders throughout the industry have pursued a strategy of ‘‘ combination’’ stores by adding more shelving and product categories to existing stores to incorporate more inventory. Many supermarkets have become near shopping malls in their own right, adding pharmacies, florists, dine-in restaurants, etc. Prominent examples of firms that are successful with this format include two general merchandise retailers, Dollar General and Family Dollar. Both chains compete for the same target market as Wal-Mart, both are competitive with Wal-Mart on price, and both have over 3000 stores in the US, yet the average store size is 6000 ft2 vs. Wal-Mart’s average 92, 000 ft2. One strategy of Dollar General is to locate stores next to existing Wal-Marts to highlight their convenience. Wal-Mart has acknowledged these competitors and has begun experimenting with a ‘‘ Small-Mart’’ strategy of far smaller stores. In the grocery industry, the small-store, but non dense strategy is generally known as a ‘‘ limited assortment’’ strategy. Limited assortment stores generally are 20–40% of the size of the average supermarket and stock only a few SKUs in each category. The purpose of this work was to provide the means to manage a dense store. Current retail inventory practices are not adequate to the task. Consequently, they devised an

inventory replenishment policy for the retail sector that supports a dense store format. Inventory practices are known by the industry to be largely inefficient. The optimum use of store and shelf space to provide a complete, easy to shop, assortment of products the consumer wants. The idea behind ESA is to enable more space for broader assortments per category or for new categories. Research supports this and provides a new tool to achieve this result. 1. 2. The practical impact of replenishment modellingThere are generally three hierarchical levels of retail inventory policy: Assortment — deciding which products should be stocked, Allocation — how much shelf space to give each product in the assortment, andReplenishment — when and how much to reorder. The focus here is on finding a simple model for inventory replenishment that enables retail managers to make greater use of their scarce resource: retail space. This inventory reduction has ramifications for the assortment/ allocation decisions, as it lessens the need for shelf space assigned to the current assortment. Given a static store size, this enables higher variety through either the addition of more products in a category or the inclusion of more general categories of goods. Alternatively, the reduction in space needs can lead to smaller stores or more aisles per store.

Conclusions

Excessive inventory levels are impeding profitability and the provision to management of points on a trade-off curve between inventory of current goods and inclusion of other categories. The excessive inventory levels seen in the industry have a historical and reasonable basis — logistics practices, supply chain relationships and information systems of a decade ago

necessitated larger inventories. The implementation of ECR practices will negate the reasons for those inventories, but inventory policy must change or those inventories will persist. The trade-off offered here is not the classic inventory versus service trade-off: traditionally, lower inventories mean lower costs and lower service. Excessive inventory levels held affect profitability through a less obvious route – by crowding out other categories of goods. A retailer with limited shelf space must face the trade-off of putting fewer categories out for sale against holding inventories of current products. But without the context of an opposing inventory policy and the associated space required, that trade-off is not defined. The trade-off now faced by the entire grocery industry is that of the cost of improving information systems and inventory practices versus providing customers with variety and convenience. This work helps to quantify that trade-off.

2. 6 Summary of Literature Reviews

Statistical process control (SPC) based replenishment method outperforms the traditional method in the categories of inventory variation, and in the number of backlog when the fill-rate of the prior model is set to be 99%, by choosing a suitable replenishment policy, the number of backorder and the cost of inventory can be reduced. Inventory managers can reduce the inventory cost by properly choosing replenishment methods without many calculation tasks. The SPC-based inventory control techniques, which monitor the demand and inventory on an ongoing basis, can adjust replenish quantity dynamically. We learned about various Inventory Myths like sophisticated techniques and organisational discipline will provide more accurate sales forecasts, Just-In-Time, will eliminate inventory problems,

inventory provides the necessary buffer to protect manufacturing from seasonal and business cycle variations, Local dealers need to be backed up by readily available regional stocks, Modern information systems and control methods will all but eliminate obsolete and slow-moving inventories etc. The barriers to a supply chain approach are tradition, organisational, legal and non integrated management systems. Traditionally, supply chains of necessity have been managed and controlled functionally. The analytical tools necessary to analyse and control complex and often multinational supply chains are now available. It is clear that the use of these tools can provide firms with the opportunity to use their inventory and distribution systems to gain competitive advantage in the market segments they serve. Inventory monitoring and measurement is not the same as inventory control, It is much more than stock checking, It is concerned with warehouse management and knowing all about the stock in the warehouse in terms of location and time. Excessive inventory levels are impeding profitability and the provision to management of points on a trade-off curve between inventory of current goods and inclusion of other categories. The trade-off offered here is not the classic inventory versus service trade-off: traditionally, lower inventories mean lower costs and lower service. Excessive inventory levels held affect profitability through a less obvious route – by crowding out other categories of goods. The trade-off now faced by the entire grocery industry is that of the cost of improving information systems and inventory practices versus providing customers with variety and convenience.

Research Methodology

We use simulation as research method. This allowed us to study the impact of several factors that are measures of Inventory performance and various costs associated with it. Simulation models are often used when certain characteristics of the supply chain cannot easily be modelled with analytical models or when stochastic variables are to be incorporated. They are useful to understand complex systems. Simulation models do not optimize Inventory. Instead, they allow determining the performance of given inventory measures. Our simulation model uses discrete and constant time intervals. Demand, orders and other variables related to inventory replenishment. Each simulation was run for 1000 days. We start with the calculation of the performance measures in review period of 7 days with customer demand normally distributed and lead time uniformly distributed.

3. 1 Simulation Model Development

A number of parameters need to be estimated and several relationships between variables and parameters have to be defined when building a simulation model. We have tried to find reasonable estimates for the parameters and relationships, and are not aware that our conclusions would change due to a variation in any of the parameters or relationships (e. g. lead times, order sizes). For our model, we assume a low value CPG (consumer packed goods), noodles unit cost Rs. 10 that is sold in supermarkets and all other retail stores too. End-customers demand a certain quantity of a SKU from the retailer each day. The retailer can fulfil customer demand as long as items are in stock. It is assumed that end-customers whose orders could not be fulfilled immediately are prepared to

wait for next week’s delivery. These orders enter the order backlog. This assumption is somewhat idealistic for the retailer as customers react in different ways to stock-outs. They can buy a different SKU, buy the SKU elsewhere, came back later, or decide not to be the product at all. The retailer places an order at end of each review period, taking into account end-customer demand, available inventory and backorders. The simulation project undertaken had the following objectives in order to understand the performance of the proposed inventory ordering policy: Evaluate the (R, S) ordering policy for the stated inventory problemCompare alternative replenishment policies by changing the order up to level and review periodEvaluate the selected ordering policy performance before its actual implementation considering that the inventory reordering in the firm studied is done daily, was selected for advancing the simulation clock. Finally, the results of these simulations were compared. The modelling has been done particularly for one grocery item, which in this case are noodles. Daily transaction reports carried by each retail store were the main source for the initial data required to build the simulation models. No transaction cost was considered relevant for the model. Other important sources of information were price lists, accounting records, organization manuals, and useful conversations and interviews with employees. Considering the demand as a discrete random variable, normally distributed. Simulation has been done for 6 different Review periods with six different order up to level, where lead time is uniformly distributed between two to four days.

Assumptions:

Average demand of the product = 50Standard deviation of Demand = 10Cost of the Product = Rs. 10Inventory Holding Cost = 10% of Product CostBackordering Cost = Rs. 1/UnitLead Time= Uniformly Distributed between 2 to 4 Days

Event Type Description

Arrival of an order from the supplierDemand of the product from a consumerUpdate inventory levelInventory evaluation (and possible ordering) at the end of a review periodEnd of simulation after 1000 daysIn order to evaluate the performance of the different ordering policies (by changing the order up to level and review period parameter), the following performance measures were used: Average total inventory costs TIC (sum of ordering backordering, and Inventory carrying costs). Average Fill Rate measure (% of total items demanded from inventory without stockout). For the model construction, Microsoft Excel was used.

Analysis of Simulation Results

After running the simulation model for 1000 runs, i. e. for 1000 days, for 6 different R (Review Periods) and six different S (order up to level), we saw different types of variations in the total variable cost and the inventory performance measures. We took six different review periods from 7 days to 12 days and six different order upto level from 300 units to 550 units. We did the simulation for total thirty six different combinations of review periods and order upto level units. Results obtained by these simulations are shown in following tables. Review Periods are in days, all the backorders and Ending

Inventories are in units, where as Fill rate is in % and all the costs are in rupees.

Keeping OUL fix and changing Review Periods

Table 1: For Six different Review Periods, when OUL= 300 Units

OUL= 300 Units

Review Period

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

7

10. 655104. 88479. 2310. 65514. 210. 488435. 3434

8

11. 622111. 51977. 5811. 62212. 511. 151935. 2739

9

12. 186120. 05476. 0512. 18611. 112. 005435. 2914

10

12. 496129. 02875. 3912. 4961012. 902835. 3988

11

13. 324139. 03273. 8713. 324913. 903236. 2272

12

14. 141146. 19872. 2314. 1418. 314. 619837. 0608

Table 2: For Six different Review Periods, when OUL= 350 Units

OUL= 350 Units

Review Period

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

7

8. 217120. 43383. 878. 21714. 212. 043334. 4603

8

9. 088124. 1982. 139. 08812. 512. 41934. 007

9

9. 899132. 95980. 419. 89911. 113. 295934. 2949

10

10. 642144. 39479. 0810. 6421014. 439435. 0814

11

11. 341152. 06777. 5911. 341915. 206735. 5477

12

12. 244158. 32675. 5312. 2448. 315. 832636. 3766

Table 3: For Six different Review Periods, when OUL= 400 Units

OUL= 400 Units

Review Period

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

7

5. 958135. 05888. 35. 95814. 213. 505833. 6638

8

7. 042139. 28786. 227. 04212. 513. 928733. 4707

9

8. 026147. 23584. 038. 02611. 114. 723533. 8495

10

8. 974159. 30482. 328. 9741015. 930434. 9044

11

9. 749167. 82580. 699. 749916. 782535. 5315

12

10. 704174. 69378. 6610. 7048. 317. 469336. 4733

Table 4: For Six different Review Periods, when OUL= 450 Units

OUL= 450 Units

Review Period

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

7

4. 052152. 46192. 064. 05214. 215. 246133. 4981

8

5. 495155. 90489. 465. 49512. 515. 590433. 5854

9

6. 524164. 02687. 156. 52411. 116. 402634. 0266

10

7. 313173. 91785. 557. 3131017. 391734. 7047

11

8. 374185. 15283. 588. 374918. 515235. 8892

12

9. 493191. 19381. 229. 4938. 319. 119336. 9123

Table 5: For Six different Review Periods, when OUL= 500 Units

OUL= 500 Units

Review Period

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

7

2. 046175. 15196. 022. 04614. 217. 515133. 7611

8

3. 326173. 47593. 533. 32612. 517. 347533. 1735

9

4. 45177. 09891. 104. 4511. 117. 709833. 2598

10

5. 674191. 16888. 825. 6741019. 116834. 7908

11

6. 629198. 29286. 876. 629919. 829235. 4582

12

7. 688207. 15984. 697. 6888. 320. 715936. 7039

Table 6: For Six different Review Periods, when OUL= 550 Units

OUL= 550 Units

Review Period

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

7

0. 704205. 81998. 620. 70414. 220. 589935. 4939

8

1. 593193. 67396. 921. 59312. 519. 369533. 4625

9

2. 761193. 77694. 462. 76111. 119. 377633. 2386

10

4. 064206. 39691. 994. 0641020. 639634. 7036

11

5. 149216. 8389. 755. 149921. 68335. 832

12

6. 248221. 90287. 566. 2488. 322. 190236. 7382

Keeping Review period fix and changing Order upto level

Table 7: For Six different OUL, when Review Periods = 7 Days

Review Period = 7 Days

OUL

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

300

10. 655104. 88479. 2310. 65514. 210. 488435. 3434

350

8. 217120. 43383. 878. 21714. 212. 043334. 4603

400

5. 958135. 05888. 305. 95814. 213. 505833. 6638

450

4. 052152. 46192. 064. 05214. 215. 246133. 4981

500

2. 046175. 15196. 022. 04614. 217. 515133. 7611

550

0. 704205. 81998. 630. 70414. 220. 589935. 4939

Table 8: For Six different OUL, when Review Periods = 8 Days

Review Period = 8 Days

OUL

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

300

11. 622111. 51977. 5811. 62212. 511. 151935. 2739

350

9. 088124. 1982. 139. 08812. 512. 41934. 007

400

7. 042139. 28786. 227. 04212. 513. 928733. 4707

450

5. 495155. 90489. 465. 49512. 515. 590433. 5854

500

3. 326173. 47593. 533. 32612. 517. 347533. 1735

550

1. 593193. 67396. 931. 59312. 519. 369533. 4625

Table 9: For Six different OUL, when Review Periods = 9 Days

Review Period = 9 Days

OUL

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

300

12. 186120. 05476. 0512. 18611. 112. 005435. 2914

350

9. 899132. 95980. 419. 89911. 113. 295934. 2949

400

8. 026147. 23584. 038. 02611. 114. 723533. 8495

450

6. 524164. 02687. 156. 52411. 116. 402634. 0266

500

4. 45177. 09891. 104. 4511. 117. 709833. 2598

550

2. 761

193. 776

94. 46

2. 761

11. 1

19. 3776

33. 2386

Table 10: For Six different OUL, when Review Periods = 10 Days

Review Period = 10 Days

OUL

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

300

12. 496129. 02875. 3912. 4961012. 902835. 3988

350

10. 642144. 39479. 0810. 6421014. 439435. 0814

400

8. 974159. 30482. 328. 9741015. 930434. 9044

450

7. 313173. 91785. 557. 3131017. 391734. 7047

500

5. 674191. 16888. 825. 6741019. 116834. 7908

550

4. 064206. 39691. 994. 0641020. 639634. 7036

Table 11: For Six different OUL, when Review Periods = 11 Days

Review Period = 11 Days

OUL

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

300

13. 324139. 03273. 8713. 324913. 903236. 2272

350

11. 341152. 06777. 5911. 341915. 206735. 5477

400

9. 749167. 82580. 699. 749916. 782535. 5315

450

8. 374185. 15283. 588. 374918. 515235. 8892

500

6. 629198. 29286. 876. 629919. 829235. 4582

550

5. 149216. 8389. 765. 149921. 68335. 832

Table 12: For Six different OUL, when Review Periods = 12 Days

Review Period = 12 Days

OUL

Back Order

End. Inv.

Fill Rate (%)

Backordering Cost

Ordering Cost

Inv. Carrying Cost

Total Variable Cost

300

14. 141146. 19872. 2314. 1418. 314. 619837. 0608

350

12. 244158. 32675. 5312. 2448. 315. 832636. 3766

400

10. 704174. 69378. 6610. 7048. 317. 469336. 4733

450

9. 493191. 19381. 229. 4938. 319. 119336. 9123

500

7. 688207. 15984. 697. 6888. 320. 715936. 7039

550

6. 248221. 90287. 566. 2488. 322. 190236. 7382

Total Variable Cost Measures:

To calculate total variable cost, we have considered Ordering cost, Backordering Cost and Inventory Carrying Cost. For any fix order upto level, we saw that total variable cost is going down from 7 or 8 days of review period but again going up when review period was 10. Cost is coming to be lowest when review period is 8 days and order upto level is 500 units. Total variable cost in this case is coming to be Rs. 33. 174. Only the graph with minimum cost has been shown below, all other graphs are shown in appendix. Again when we analysed keeping review period same with respect to various order upto levels and we saw that for review period of 7 days total variable cost is going down till OUL of 450 and again goes up for OUL of 500 units and above. For review period of 8 and 10 days this cost is going down till an OUL of 500 units and goes up beyond that. For review period of 9 and 11 days cost is coming down till an OUL of 400 units and then it goes up beyond that level. For review period of 12 days, total variable cost is maximum at an OUL of 300 units and comes down at 350 units but again goes up beyond that level.

Measures of Inventory Performance:

For measuring Inventory performance we have take into account back order, ending inventory and fill rate on per day basis. We saw that fill rate is

maximum for an OUL of 550 units for a review period of 7 days, which is 98. 63%. Ending Inventory as well as backorder is going up with increasing OUL units as well as increasing review periods. Backorder is minimum at an OUL of 550 units which is 0. 704 units.

Conclusions & Recommendations

The simulation study conducted revealed important information regarding the proposed inventory model performance, as it will allow the firm to gain valuable experience in implementing the system ahead of time. The (R, S) ordering policy proved to be an effective way of leveling the tradeoffs involved in this complex real world situation. The model structure offers also a reliable and efficient method to deal with the dynamic environment faced by the retailers. The simulation model developed assisted in the decision making process reengineer the operation of the retailers in terms of customer service and operating costs. The improvements will eventually lead the company to fulfill its organizational and business objectives. From the analysis of various (R, S) models, we can conclude that if a firm’s first priority is minimization of cost then it can go for the replenishment policy which gives minimum total variable cost. In this case, when the review period is 8 days and the order upto level of 500 units, the total variable cost comes out to Rs. 33. 174 per day with the fill rate of 93. 53%. But if a firm’s first concern is to maintain high level of customer service, it has to ensure maximum fill rate. In this case, it can go for an order upto level of 550 units with review period of 7 days which will provide the fill rate is 98. 63% per day. Total variable cost in this case is comes out to Rs. 35. 5. So, we can see that there should is a trade-off between operating at minimum possible cost

and maintaining high level of customer service. Hence one has to strike a balance between the given minimum coat and customer service.

Limitations of the Research Work:

Data used in this research work for all calculation purposes, is not original, it has been generated through Simulation model. Demand is assumed to be normally distributed and lead time uniformly distributed between two to four days.

Bibliography

Matching Supply with Demand: An Introduction to Operations Management" (McGraw Hill, 2009) by Gérard Cachon and Christian Terwiesch, the Wharton School, University of Pennsylvania. Designing and Managing the Supply Chain by David Simchi-Levi, Philip Kaminsky Edith Simchi-Levi, Ravi ShankarOperations Research: Applications and Algorithms, By Wayne L. WinstonInternational Journal of Physical Distribution & Logistics Management, Emerald ArticlesLogistics Information ManagementInternational Journal of Productivity and Performance Management, International Journal of Operations & Production ManagementJournal of Operations Management 18_2000. 303–316Science Direct, Computers & Industrial Engineering 51 (2006) 257–263European Journal of Operational Research, www. elsevier. com/locate/ejorInternational Journal of Production Economics 81–82 (2003) 265–279International Journal of Production Researchwww. ijicic. org/ijicic-09-1063. pdfwww. jimsjournal. org/22%20Hsu-Tung%20Lee. pdf