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Proposed Model for Inventory Review Policy through ABC Analysis in an Automotive Manufacturing Industry

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Abstract: A global market inventory is one of the largest and most significant resources of a manufacturing business. ABC analysis is one of the methods used extensively in manufacturing industries for inventory classification. The familiar ABC inventory classification approach categorizes inventory items as A, B and C classes according to their annual consumption value. To direct and control the inventory items more proficiently the inventories managers regularly classify and group all the inventory items. The objective of this paper is to create a periodic review policy based on the ABC classification in order to control the raw materials more efficiently. Based on the data collected through original equipment manufacturer, the necessary analysis was carried out. From the observed results, it was found that the developed periodic review policy improved the inventory turnover ratio from 3.15 to 2.13 by optimizing the inventory level for one year.

Introduction

Inventory is a tool which is used to manage and control the ordering, storage and machinery usage of companies because most of the manufacturing companies are applying the policy of reducing their investment in fixed assets like working places, warehouses, equipment and machinery etc, which even highlights the implication of reducing inventory. A business inventory is one of its major assets and represents an investment that is joined together until the item is sold and also costs involved storing, tracking and insuring inventory. Mismanaged inventories create significant financial problems for a business organization which results in an excess inventory or material shortage. Right inventory management always engages to create a purchasing plan that will ensure that items are available when they are needed and keeping track of existing inventory and its utilization. Two common inventory management policies are Just-In-Time (JIT) method, where companies plan to receive materials as they are needed rather than maintaining high inventory levels and Materials Requirement Planning (MRP), which schedules material deliveries based on sales forecasts. Some times in a manufacturing industry, even hundreds of small size items may be held in a warehouse but for organizations maintaining thousands of inventory items, it is impractical to provide equal consideration to each of the inventory items. Inventory classification using ABC analysis is one of the most widely used techniques in manufacturing and business organizations. ABC classification allows an organization to divide the products into three classes such as: A- relatively small number of items at the top of the list about 10% consider as most important and required careful inventory control because it represents a large percentage of the total usage inventory value, C- the majority of the items at the bottom of the list about 70% consider as least important where the inventory items given a flexible control and B is the important items about 20% of the total annual usage which also requires a control effort. The purpose of classifying items is to establish appropriate levels of control over each item and easy to understand about its usage. The items are classified according to the annual usage value and this classification may not always be accurate, but it has been found too close to the existing occurrence in companies with remarkable accuracy.

Literature Review

Inventory management is the continuing process of planning, organizing and controlling inventory that aims at minimizing the investment in inventory while balancing supply and demand. The inventory expressed in terms of number of days of sales at any point of time determines the time taken to introduce a new product in market [1]. The inventory concepts and advantages of ABC classification were analysed and the various steps implemented using the ABC analysis for analyzing the original case was discussed. Appropriate measures were also proposed which proved that the ABC inventory analysis has important value in practice theoretically and practically [2]. An enhanced clustering model for the inventory management problems was proposed [3-4]. Multi objective mixed-integer linear program with total cost, total flow time, and total lost sales as key objectives was developed for addressing production, distribution, and capacity planning of global supply chains by considering cost, responsiveness, and customer service levels simultaneously [5]. Periodic review indicates that inventory status tracked at regular periodic intervals and re-order was made to raise the inventory level to the point of a pre-defined. Two extended Economic Manufacturing Quantity (EMQ) based supply chain models with a discontinuous product issuing policy, random machine breakdown and rework failures were developed to derive the optimal production run times that minimize the expected total system costs, including the costs incurred in production units, transportation and retail stores [6-7]. A method was presented for recognition and modification of the bias that exists in the ABC items classification done by inventory experts and decision makers. The classification familiarity bias was found and corrected through patterns recognition and pattern based reclassification was proposed using a multi-class model based on logical analysis of data [8]. Safety stock is a term used by logisticians to describe a level of extra stock that is maintained to mitigate risk of stock outs due to uncertainties in supply and demand. Adequate safety stock levels permit business operations to proceed according to their plans [9-10]. A customized Artificial Neural Network (ANN) model that allows changes for the decision-making process was proposed. The model employed with fuzzy analytics hierarchy process (FAHP) for determining the relative weights of the attributes used posteriorly in the ANN model with back propagation learning [11-13]. In another study AHP method, cluster analysis and artificial neural networks in a real manufacturing background were compared [14-15].

The optimal replenishment policy for order cycles of length P was recognized with assumption of an auto correlated demand and linear inventory holding and backlog costs and characterized the periodic inventory costs, availability and fill rate [16]. Carrying cost refers to the total cost of holding inventory. This includes warehousing costs such as rent, utilities and salaries, financial costs such as opportunity cost, and inventory costs related to perishability, shrinkage and insurance [17-18]. Symmetry breaking constraints in a mixed integer programming model to determine optimal and near optimal solutions were integrated with local search heuristics and evolutionary polishing heuristics to achieve effective and efficient solutions in the inventory staggering problem [19-20]. The inventory management practices of various companies and institutions were studied and compared with necessary suggestions for improvement using the ABC analysis inventory management method. The ABC analysis was found to be useful to most of the companies already in usage of this tool either manually or with an enterprise resource planning system [21-23]. A study was carried out with ABC analysis in an automotive industry for utilizing the maximum effect of cost savings. Through research and statistical calculations a proposal was made to reduce costs bound in the inventories of the companies. The new system of inventories management facilitated companies to utilize the saved money in another way and to achieve further optimization of the processes [24-25]. Based on the literature, an attempt was made to create and implement a review policy for sustaining a better level of inventory in JPCN Industries, the manufacturer of various types of brake drums situated at Chennai, Tamilnadu.

Methodology

The methodology is the use of the indicator of the policies concerned with data collection and analysis. It starts from the study of existing scenario followed by ABC analysis. The ABC analysis was carried out to classify the inventory system and based on that the new inventory Periodic Review Policy (PRP) has been developed. Data was collected from an Original Equipment Manufacturer (OEM) company whose manufacturing the brake drum was considered for this study and there are three different models of brake drums were analysed. For manufacturing these three different models there are 180 purchased items involved and among that most of the items are common for all three models. In current scenario the company is not following any ordering policies and they are ordering according to their changeable demand. The manufacturing industry carries excess inventory also due to fluctuation in demand. The methodology flow chart used for this study is shown in Figure 1.

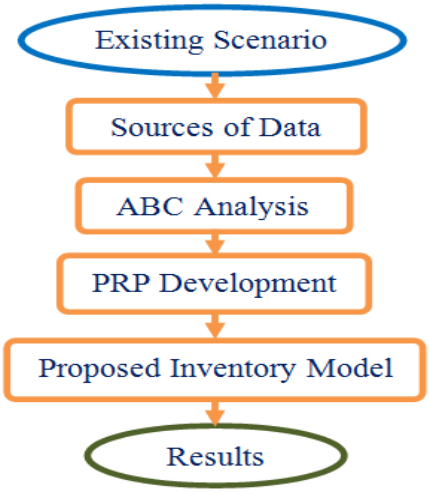

Fig. 1 Methodology Flow Chart

Data Collection and Analysis

For conducting ABC analysis and to develop the periodic review policy, the following data has been collected from the existing source. Bill of materials, standard cost of materials, customer demand, route sheet, supplier information and order statistics data were collected. Based on the existing data collected the inventory ratio of the industry was calculated and found to be 3.15 for 365 days, the average days in inventory is 102 days.

ABC Analysis: ABC classification is a method of classifying inventory items according to the money value to the organization. Class A items though smaller volumes but tends to generate higher consumption value followed by the class B items. The class C items are of a very large volume but generate a very small consumption value. The ABC approach states that a company should rate items from A to C, based on the following rules:

Item-A: These are the goods with highest annual consumption value, the top 70-80% of the annual consumption value of the company typically accounts for only 10-20% of total inventory items.

Item-B: These are the interclass items, with a medium consumption value, that 15-25% of annual consumption value typically accounts for 30% of total inventory items.

Item-C: These are on the contrary items with the lowest consumption value, the lower 5% of the annual consumption value typically accounts for 50% of total inventory items.

ABC analysis executions methods are as follows,

- Classify the items of inventories determining the expected use in units and the price per unit for each item.
- Determine the total value for each item by multiplying the expected units by its unit price.
- Rank the items in accordance with the total value, giving first rank to the items with highest total value and so on.
- Compute the ratio of number of units of each item to total units of all items and the ratio of total value of each item to total value of all items.
- Combine the items on the basis of their relative value to form three categories A, B and C.

The ABC classification with percentage of objects and percentage of yearly utilization value is shown in the following Table 1.

Table 1. ABC Classification

Category	% of Objects	% of Yearly Utilization Value
A	10/180 = 5.6	75
B	22/180 =12.22	20
C	148/180=82.22	5

Periodic Review Policy

In a periodic inventory system also referred to as a fixed time-period system or a periodic review system, the inventory on hand is counted at specific time intervals for example every week or at the end of each month. After the inventory in stock is determined, an order is placed for an amount that will bring inventory back up to a desired level. At the regular intervals inventory is reviewed and replenished. In this project, replenishment level is calculated based on the stock on hand, demand and minimum order quantity. The order of occurrence based on the category for weekly, bi-weekly and monthly is shown in Table 2.

Table 2. Order of Occurrence

Category	No. of Objects	Occurrence Order/Dispatch
A	10	Weekly
B	22	Bi-weekly
C	148	Monthly

Minimum order quantity (MOQ) identifies the lowest quantity of a certain product that the supplier is willing to sell. Order date is nothing but the date on which a certain product is ordered. Order date will be decided based on the supplier lead time and manufacturing lead time. Actual demand is the initial demand proposed by the customer and updated demand is the demand finalized by the customer in each month. The raw materials kept on the premises of the industry that is available for the production purpose is called stock. Actual order quantity gives an idea about the quantity that is to be ordered based on actual demand. Updated order quantity indicates how much quantity should be ordered on the basis of updated demand. Planned order quantity helps to decide whether to order actual order quantity or updated order quantity based on order date and updated date. Release order quantity specifies the final quantity that is to be ordered.

Real Order Quantity: This is obtained by analyzing the logical expressions which was formulated with ‘actual demand’, ‘MOQ’ and ‘stock’ as key parameters. The real order quantity model is shown in Figure 2.

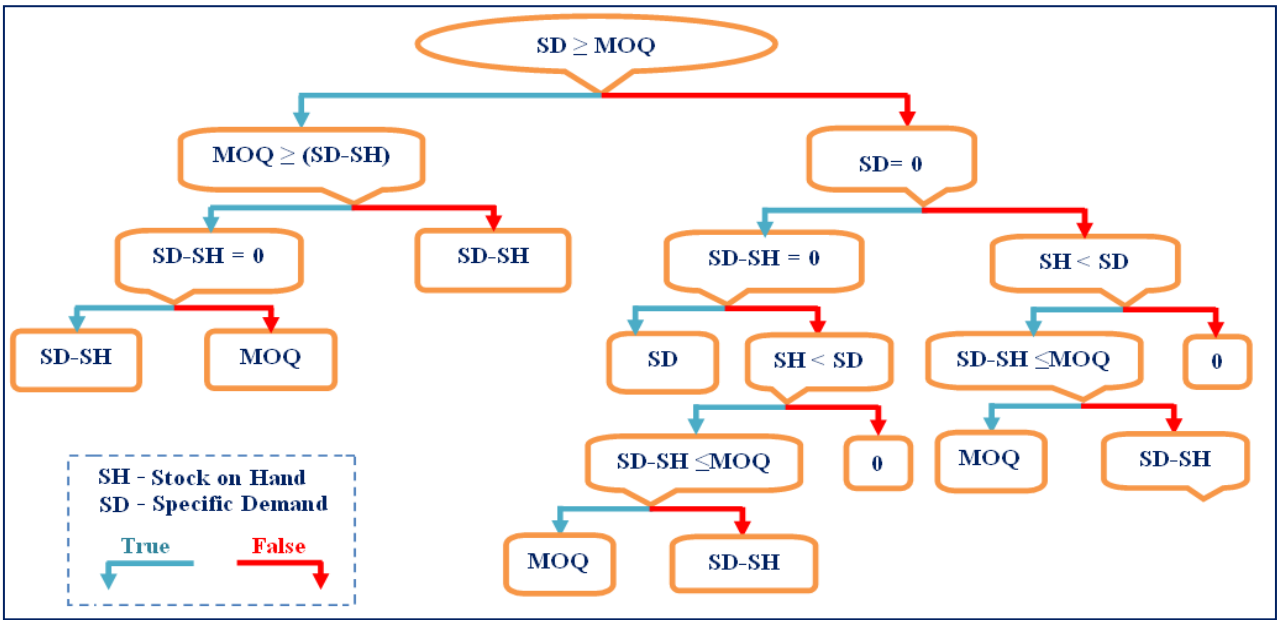

Fig. 2 Model for Real Order Quantity

Revised Order Quantity: Updated order quantity is found out by analyzing the logical expressions which was formulated with 'updated demand', 'MOQ' and 'stock' as key parameters. The model for the revised order quantity is shown in Figure 3.

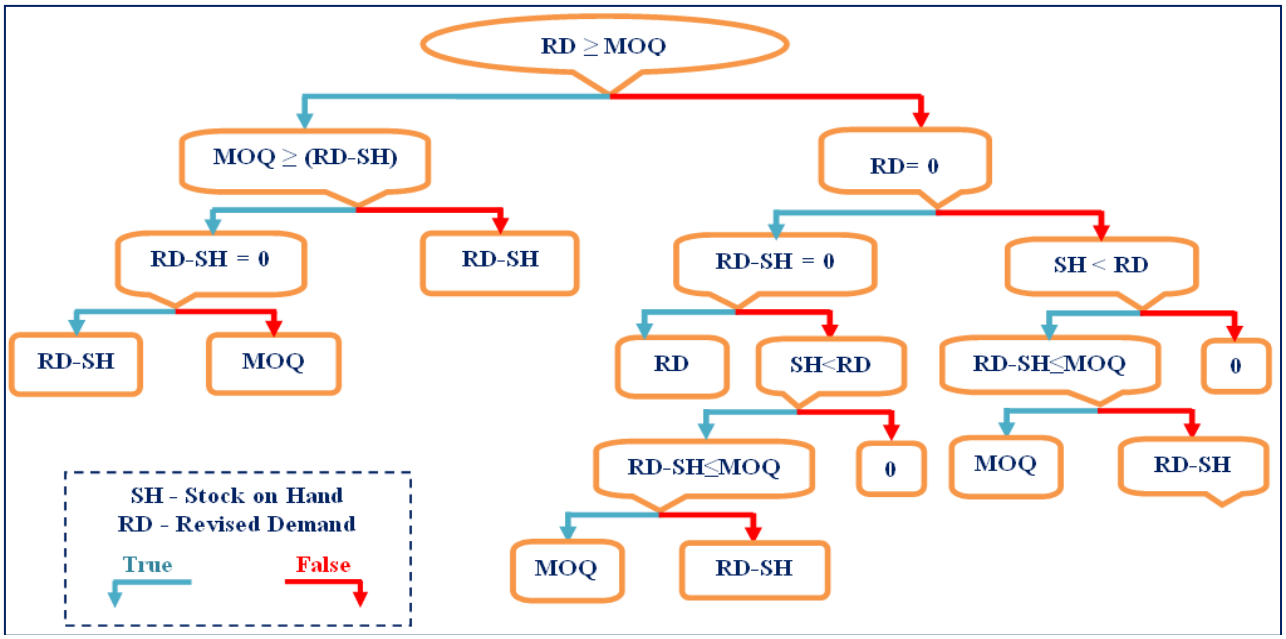

Fig. 3 Model for Revised Order Quantity

Proposed Order Quantity: Proposed order quantity is the quantity which is planned to be ordered based on order date and updated date. Updated date is nothing but the demand proposed by the customer in every month. The model for the proposed order quantity is shown in Figure 4.

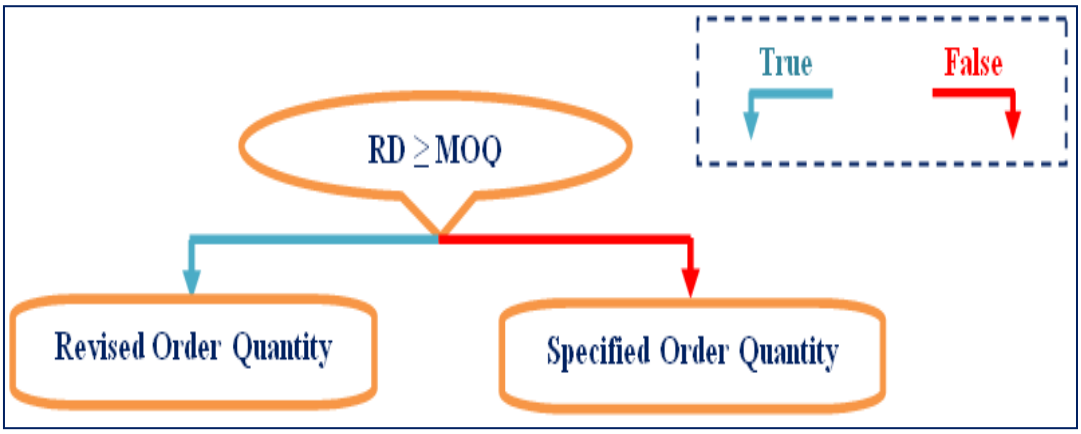

Fig 4. Model for Proposed Order Quantity

Release Order Quantity: The release order quantity model for class A and B is shown in the following Figure 5. Similarly for class C the model for release order quantity is shown in Figure 6. The release order quantity calculation for class A, B and C items are as follows.

For Class A items: Order Frequency - Weekly
For Class B items: Order Frequency - Every two weeks
For class C items: Order Frequency - Every Four weeks
Release order quantity = Planned order quantity

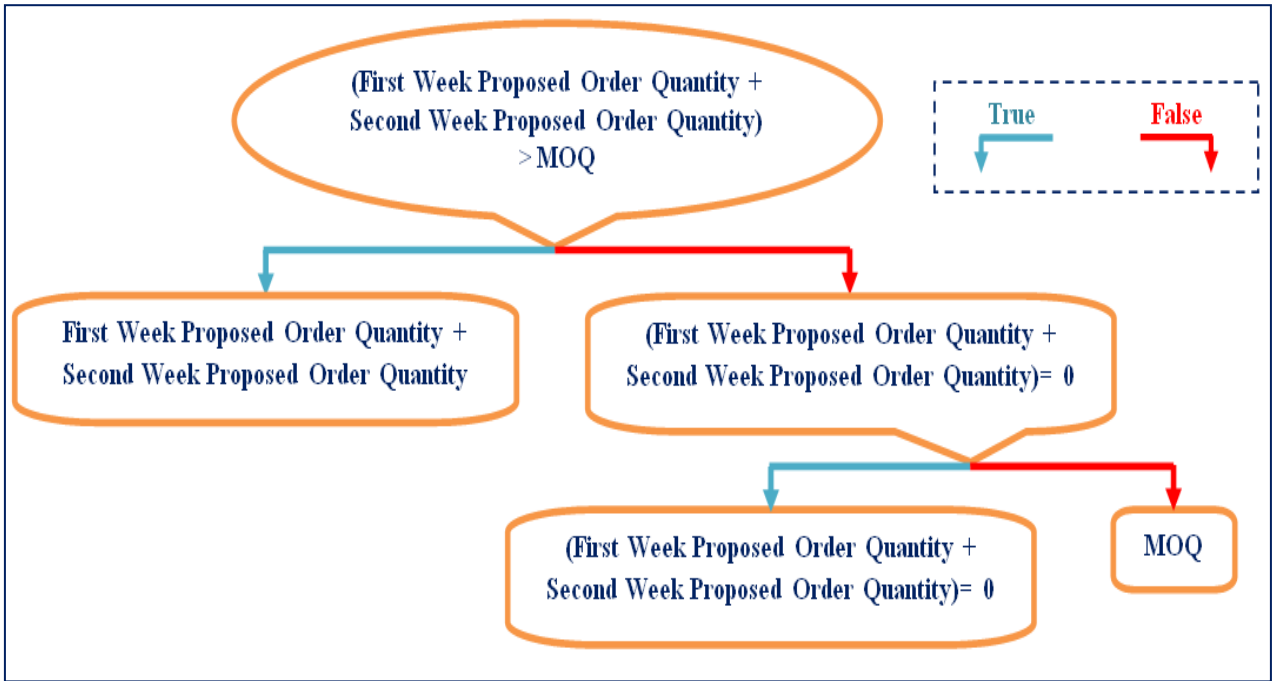

Fig. 5 Release Order Quantity Model for Class A and B

These logical expressions are developed using excel and that will decide how much quantity to order based on minimum order quantity, Stock on hand and demand. Order date will be decided based on the supplier lead time and manufacturing lead time for each material. Proposed model will tell us how much to order and when to order for each items. This ABC classification will give importance based on the annual consumption value and also helps purchase managers to focus on items which provide high cost savings rather than give importance to all the items equally.

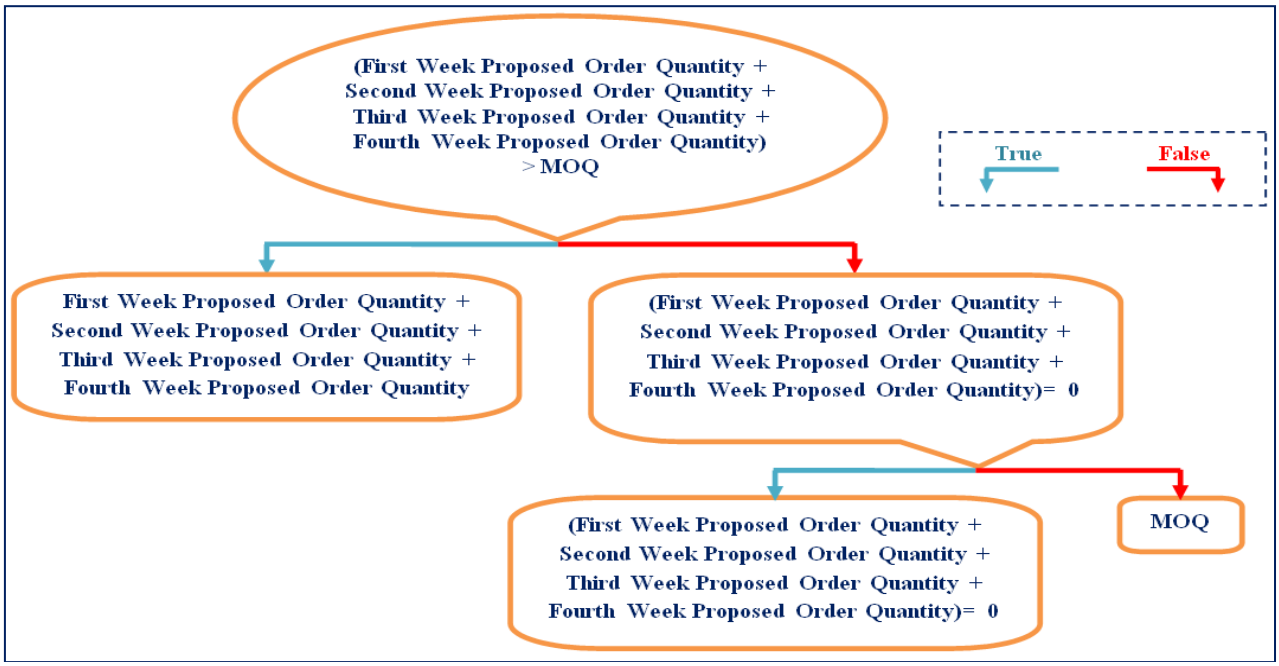

Fig. 6 Release Order Quantity Model for Class C

The following Table 3 shows the proposed model for one of the raw materials which is used for the production that will indicate how many to order and when to order. After implementing the proposed periodic review policy the inventory ratio was calculated and found that 2.13 for 365 days for the average days of inventory are 102.

Table 3. Proposed Model of Raw Material ID BD17199 for One Year

Component No. - BD17199	Castings	Class A	Design - N1710
Month/Week	Order Quantity	Date of Order	Stock on Hand
July 2015			
1st Week	4	07-07-2015	3
2nd Week	0	14-07-2015	3
3rd Week	0	21-07-2015	3
4th Week	0	28-07-2015	2
Aug. 2015			
1st Week	0	04-08-2015	2
2nd Week	0	11-08-2015	2
3rd Week	0	18-08-2015	2
4th Week	4	25-08-2015	6
Sep. 2015			
1st Week	0	01-09-2015	5
2nd Week	4	08-09-2015	6
3rd Week	0	15-09-2015	4
4th Week	4	22-09-2015	3
5th Week	0	29-09-2015	1
Oct. 2015			
1st Week	4	06-10-2015	0
2nd Week	4	13-10-2015	3
3rd Week	4	20-10-2015	0
4th Week	4	27-10-2015	1
Nov. 2015			
1st Week	4	03-11-2015	6
2nd Week	8	10-11-2015	5

3rd Week	4	17-11-2015	3
4th Week	4	24-11-2015	3
Dec. 2015			
1st Week	4	01-12-2015	2
2nd Week	4	08-12-2015	2
3rd Week	4	15-12-2015	3
4th Week	4	22-12-2015	3
5th Week	4	29-12-2015	2
Jan. 2016			
1st Week	4	05-01-2016	2
2nd Week	4	12-01-2016	1
3rd Week	4	19-01-2016	0
4th Week	4	26-01-2016	0
Feb. 2016			
1st Week	4	02-02-2016	0
2nd Week	4	09-02-2016	1
3rd Week	4	16-02-2016	2
4th Week	4	23-02-2016	2
March 2016			
1st Week	4	01-03-2016	3
2nd Week	4	08-03-2016	3
3rd Week	4	15-03-2016	0
4th Week	4	22-03-2016	0
5th Week	0	29-03-2016	0
April 2016			
1st Week	4	05-04-2016	1
2nd Week	4	12-04-2016	1
3rd Week	4	19-04-2016	2
4th Week	4	26-04-2016	2
May 2016			
1st Week	4	03-05-2016	2
2nd Week	4	10-05-2016	2
3rd Week	4	17-05-2016	2
4th Week	4	24-05-2016	2
5th Week	4	31-05-2016	3
June 2016			
1st Week	4	07-06-2016	3
2nd Week	0	14-06-2016	0
3rd Week	4	21-06-2016	0
4th Week	4	28-06-2016	2

Conclusions

A periodical review policy for sustaining the inventory level in a manufacturing industry was proposed. The purpose of the product classification is to ensure that the purchasing staff has to concentrate on those items that have the greatest potential savings. Based on the analysis, the following conclusions were arrived:

- This research work helped to implement selective control that would be more effective than an approach that treats all items identically.
- Ultimately the proposed model would improve the inventory turnover ratio by optimizing the inventory level.

- After execution of the proposed periodic review policy the inventory ratio was reduced from 3.15 to 2.13 for one year with 102 days as the average days of inventory.
- But there may be chances of occurrence for shortage of items due to the variation of supplier lead time and demand fluctuation but the same may be overcome by maintaining safety stock.

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