Joint Order of Multi-item Inventory Control Model

Takes the Operation Center of D Express Enterprise as an Example

Yu Tian
School of Economics and Management
Beijing Jiaotong University
Beijing, China
tyfight@126.com

***Abstract*—The paper takes the operation center of D company as an example, studies the packing material inventory control. Grouping by ABC classification, the paper establishes the joint order of multi-item inventory control model to determine the optimal order cycle, achieving the purpose of reducing inventory levels and inventory cost.**

Keywords-packing materials; inventory; joint order; multi-item

I. INTRODUCTION

The research of multi-item inventory control model and algorithm have certain development, achieved results in some respects, but has not formed systematic theory and method like single species inventory control theory. The application in different areas still needs to study further [1].

D company is an international air express company. It has three operation centers in Beijing partition. The services will include Beijing, Tianjin and Hebei, the number of import and export express is large, so monthly packaging material usage is very large. The company all the packaging materials are provided to the customers freely and not allowed out of stock at the same time. At present, the company's packaging material is unwatched so the order quantity often vary widely, caused the problem such as overstock, higher inventory costs. The company is eager to solve the problem of packaging material inventory, reduce inventory take up space and reduce the cost. The paper is based on this research background, embarking from the D company actual situation, studies the packing material inventory control problems in order to reduce costs, reduce inventory levels.

II. ABC CLASSIFICATION

ABC classification is also called Pareto analysis, also called primary and secondary factors analysis. It is a kind of method that is commonly used in project management [2]. It is according to the main characteristics of things in technology or economic aspect to classify queue and distinguish the key and general, which to determine the management method differently [3]. Since the analysis object is divided into A, B, C three categories, so also known as the ABC analysis method.

It includes the following steps:

A. Collect the Data

To determine factors constitute a management problem, collecting the characteristics of the corresponding data. For example, inventory control involves a variety of materials. If intends to analyze the inventory item's sales, should collect annual sales data, item price, etc.

B. Calculation and Summary

Process the collected data and calculate according to the requirement, including numerical calculation characteristics, percentage of features numerical value accounted for total numerical value, cumulative percentage, number of factors and their percentage of total number of factors, the cumulative percentage [4].

C. List ABC Analysis Chart According to a Certain Standard

There is no strict rule about division standard of all kinds of factors. We often called the cumulative percentage of main characteristic value added to 70%- 80% as class A, the cumulative percentage within the range of 10% -20% as class B, the cumulative percentage about 10% as the class C.

D. Equations

The abscissa denotes the cumulative percentage of factors and the ordinate denotes the cumulative percentage of main characteristic value [5]. According to the corresponding relationship of the ABC analysis table, take point on coordinate diagram and link each point into curve to draw ABC analysis chart. Besides using rectangular coordinate, the analysis chart can be drawn into the histogram.

III. JOINT ORDER OF MULTI-ITEM INVENTORY MODEL

A. Background Description

The In this paper, we discuss joint order of multi-item inventory control problem. This kind problem based on the background as follow: a company needs to make many varieties of products procurement plan. If at some point, send an order to for several items, for every kind of things need to pay a certain amount of order cost. In addition, the company needs to pay for basic order cost too [6]. The basic subscription cost is only related to the number of ordering and has nothing to do with the products types of each order. Therefore, company can purchasing multiple items through joint order to achieve the goal of reducing cost [7].

B. Model Hypothesis and Symbol Description

- annual demand is known

- not allowed out of stock
- lead time is 0
- A indicates the subscription cost, it is is only related to the number of ordering and has nothing to do with the goods types of each order
- a_i indicates the additional subscription cost of the product i
- D_i indicates demand of the product i
- c_i indicates the unit price of product i
- n indicates the number of product species
- h indicates Inventory holding cost per unit time per unit product percentage of unit price of product i

C. Model Building and Solving

Under the condition of assumption, all products have a common order period T[6]. Because every time when you place an order each product order one time, the product i order quantity is:

$$Q_i = D_i T \tag{1}$$

The average inventory level of product i is:

$$I_i = \frac{Q_i}{2} = \frac{D_i T}{2} \tag{2}$$

When n products joint order, the average inventory cost per unit time is:

$$TC = \frac{A + \sum_{i=1}^{n} a_i}{T} + \sum_{i=1}^{n} \frac{D_i T h c_i}{2} \tag{3}$$

Because $\frac{\partial^2 TC(T)}{\partial T^2}$ f 0, so make $\frac{\partial TC(T)}{\partial T} = 0$ can get the optimal order cycle:

$$T^* = \sqrt{\frac{2(A + \sum_{i=1}^{n} a_i)}{h \sum_{i=1}^{n} D_i c_i}} \tag{4}$$

So substitute (4)into(3), we can get the optimal average total cost:

$$TC^* = \sqrt{2(A + \sum_{i=1}^{n} a_i) \mathrm{h} \sum_{i=1}^{n} D_i c_i} \tag{5}$$

IV. The Application in the Operation Center of D Express Enterprise

The operation center of D express enterprise, need to purchase 55 kinds of packaging materials and different kind packaging material demand has very big difference. First of all, make ABC classification of all the packaging materials. Then use multi-item inventory control model to get optimal order cycle of Class A and Class B respectively. The demand of Class C packaging material is little, temporarily not to consider .

A. ABC Classification of Packaging Materials

Arrange by cumulative percentage of species and occupied capital:

TABLE I. Data Processing Chart of ABC Classification

The Serial Number	Cumulative Percentage of Species	Cumulative Percentage of Occupied Capital
1	1.82	12.39
2	3.64	23.18
3	5.45	30.86
……		
20	36.36	95.14
21	38.18	96.01
22	40.00	96.84
……		
53	96.36	100.00
54	98.18	100.00
55	100.00	100.00

The operation center of D express enterprise packaging material ABC classification results are as follows:

TABLE II. Result Chart of ABC Classification

Classification	The Number of Species	Percentage of Species	Percentage of Occupied Capital
A	10	18.18 %	71.98 %
B	12	21.82 %	24.86%
C	33	60%	3.16%

B. Joint Order of Muti-item Inventory Model

The subscription cost A of each order is 50， inventory holding cost per unit time per unit product percentage of unit price of product i h=15%, the additional subscription cost of the product i ai, indicates demand of the product i Di and the unit price of product I ci shown in table

1) The Application of Class A packing material: Put data into the formula (4), we will get the optimal ordering cycle of Class A packing material.

$$T^*_A = 0.0935(\psi\varepsilon\alpha\rho) \approx 5(\omega\varepsilon\varepsilon\kappa)$$

$$TC^*_A = 8244.14(\psi\upsilon\alpha\nu)$$

TABLE III. RELEVANT DATA ABOUT CLASS A PACKING MATERIAL

The Serial Number	c_i	D_i	a_i ($a_i = c_i$ *10%)
1	106	954	10.6
2	99.2	888	9.92
3	356	176	35.6
4	980	58	98
5	205	267	20.5
6	980	54	98
7	210	242	21
8	75.5	574	7.55
9	139	283	13.9
10	205	184	20.5

2) The Application of Class B Packing Material

Put data into the formula 4, we will get the optimal ordering cycle of Class A packing material.

$$T^*_B = 0.1346(\psi\varepsilon\alpha\rho) \approx 7(\omega\varepsilon\varepsilon\kappa)$$

$$TC^*_B = 3490.44(\psi\upsilon\alpha\nu)$$

TABLE IV. RELEVANT DATA ABOUT CLASS B PACKING MATERIAL

The Serial Number	c_i	D_i	a_i ($a_i = c_i$ *10%)
11	136	272	13.6
12	228	153	22.8
13	43.9	436	4.39
14	62.2	285	6.22
15	176	100	17.6
16	54.3	273	5.43
17	130	111	13
18	79.7	177	7.97
19	34.5	280	3.45
20	140	69	14
21	393.76	18	39.376
22	23.4	289	2.34

V. CONCLUSION

The operation center of D express enterprise has many kinds of packaging material .If not make classification, all the material ordered at the same time, would increase the cost [8]. This paper first make the ABC classification of packaging materials, and then use joint order multi-item inventory model for class A and class B respectively, so can reduce more costs and inventory levels. this paper use many kinds of joint ordering inventory model applied in packing material inventory control firstly, so it has certain reference meaning to other enterprises.

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