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Research on Retail Goods' Replenishment Strategy

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Abstract: Using cluster analysis to divide retail goods into stochastic demand commodities, festival commodities and seasonal commodities .in order to solve those problems. On the basis of the Cluster analysis results, analyzing the replenishment strategy of stochastic demand commodities .The paper uses the genetic algorithm BP neural network for forecasting replenishment strategy of optimal solution . As the result ,we get the maximum inventory, the optimal solution of delivery cycle and the minimum inventory cost. The retail goods' demand has positive effects on the delivery cycle, but it also increases the total cost.

Keywords: Retail goods; Cluster analysis; Replenishment strategy; Genetic algorithm BP neural network

1. Introduction

With the development of the theory of supply chain management, more and more attention based on supply chain inventory management method, enterprise awares the limitations of the supply chain environment on their own ability, improvement of inventory management play a role of has significant limitations. In fact, the competition between retailers is the competition between supply chains. Inventory is an indispensable part of the logistics activity, retail inventories support for the product and the auxiliary to upstream supply chain enterprise production decision . If the stock is small, it is difficult to meet the needs of the consumers; If the inventory is too high, it wasts the resources. The diversification and enrichment of retail goods is the key factor to attract consumer groups[1]. Today, because of price transparency and assimilation, retail profit is relatively low. There is a top priority for supermarket: how to attract customers; how to improve inventory management to improve their competitiveness. Efficient replenishment management mechanism can not only keep the reasonable inventory of each commodity, also improve the level of inventory management [2-4].

Retail goods has a big quantity and a mixed variety ,it needs large demand for products and frequent replenishment . Inventory consists of all kinds of materials and goods, it is to use or sales in a short time and stored in various types of retail organizations . In retailing, most cases, the customer purchasing products and product after transportation sentting to the customer has a certain amount of time difference .In order to make the sales activities go smoothly and the better meet the needs of customers, retail enterprises must overcome the differences of time. Market demand is changing, even may appear some unexpected situation makes demand boom or slump, inventory can rise to adjust inventory demand forecasting of uncertain problems. There are many different kinds of factors to influence the sales of retail goods, such as the cost of the fixed replenishment, fixed shipping cost, the delivery cycle and customer waiting costs per unit of time. According to commodity demand characteristics, it is necessary to use statistical methods to establish a matching inventory replenishment model [5-10].

2. Empirical

2.1. Selecting prediction objects

Demand from a wide range, the goods can be divided into the unstable and stable demand, product unstable demand is divided into seasonal commodities and gala commodities, product stability demand is divided into random demand commodities and continuous uniform requirements. Sales patterns and characteristics of commodities are different. The same inventory model can lead to certain types of goods, inventory control, accurate and other goods inventory at the same time. It is not reasonable. Different goods must match inventory control model.

Cluster analysis is mainly used for similarity to identify things, is to classify things according to their degree of similarity, and looking for something different categories of statistical analysis tools. The principle of cluster analysis is a great similarity in the same individual class and a very big difference in different kinds of individual. The study found that this law also applies to solve the problem of goods clustering, all kinds of goods within a year of monthly sales data is important basis of phase of the category. According to the sales features ,cluster analysis can divide commodities into the characteristics of similar goods category, phase far into another kind of goods. Each type of goods uses different inventory control mod-

el to improve the forecasting precision and reduce inventory risk.

To participate in the clustering of variable dimension different will lead to errors of clustering results, in front of the clustering process, a variable's value must be standardized. According to the requirement of the commodity characteristics and clustering of data, used the numerical standard to a maximum of 1, which are standardized variables or the observation with the maximum value of purify, after using the standardized data as the final clustering index clustering analysis. Through the survey data, we choose 7 kinds of goods from five classes which include Grain, edible oil, rich food, smoke wine and home appliance in Table 1.

Table 1. Monthly sales data of goods

	rice	blend oil	cereal	high-grade liquor	quhasity Wine	air fan	heater
January	98690	102430	92360	43290	56523	0	5789
February	99470	99980	102347	42450	56897	0	5962
march	97990	99680	98754	23690	20423	0	3914
April	99070	98980	89237	13046	19896	15	4085
may	98780	100240	89995	13421	19987	2049	0
June	98900	99465	97851	46890	19423	6878	0
July	99470	99640	100975	33042	19789	8042	0
August	98090	98990	99873	43690	55997	7034	0
September	98970	102340	100432	32989	19478	341	0
October	99840	100420	101020	31927	31009	0	1153
November	100970	100009	91222	44001	32078	0	4896
December	101070	100034	91049	54362	49896	0	5024

Table 2. Cluster analysis

number	goods	cluster	distance
1	rice	3	1.223
2	blend oil	3	1.242
3	cereal	3	1.203
4	high-grade liquor	2	1.041
5	quhasity wine	2	1.003
6	air fan	1	.422
7	heater	1	.334

Table 3. Cluster analysis variance table

	cluster		error		F	Sig.
	mean square	df	mean square	df		
Zscore(Jan)	6.031	2	.161	12	37.352	.000
Zscore(Feb)	6.088	2	.152	12	40.057	.000
Zscore(Mar)	6.372	2	.105	12	60.838	.000
Zscore(Apr)	5.935	2	.177	12	33.439	.000
Zscore(May)	5.575	2	.238	12	23.471	.000
Zscore(Jun)	5.981	2	.170	12	35.234	.000
Zscore(Jul)	5.926	2	.179	12	33.110	.000
Zscore(Aug)	6.018	2	.164	12	36.774	.000
Zscore(Sep)	6.150	2	.142	12	43.387	.000
Zscore(Oct)	6.049	2	.158	12	38.187	.000
Zscore(Nov)	6.339	2	.110	12	57.501	.000
Zscore(Dec)	6.211	2	.131	12	47.233	.000

Setting into a class number, k-means clustering are using SPSS (namely fast clustering). This process can be will soon be assigned to the various observation. Fast clustering requirements involved in the analysis of the variables must be numeric and at least one numeric variables, cluster variable is continuous at the same time, the rapid clustering using the Euclidean distance, each variable is equal to the weight. According to the data characteristics of standardized and clustering goals, fast clustering just can satisfy this demand in Table 2.

In Table 2, cluster 3 stands stochastic demand commodities, cluster 2 stands festival commodities,

cluster 1 stands seasonal commodities. According to Table 3, 12 variables in any kind of mean square between mean square (clustering) are far greater than the mean square error (mean square error).From the point of probability value, 12 variables make no difference between the classes of hypothesis of the probability is less than 0.001%.Variance analysis results show that involved in clustering analysis of 12 variables can distinguish various, the differences between classes is large enough, the analysis results can be used to describe the purpose.

Seasonal commodities have significant seasonal characteristics on the production, purchase and sales. The goods have season production, acquisition, seasonal sales season. In order to ensure the normal supply of seasonal goods market, the enterprise of seasonal goods generally is based on the characteristics of the production and sales to be prepared for commodities listed before. In the process of seasonal merchandise sales, it is the best way to accurate planning and grasp the peak season of the marketing scale to eliminate the off-season effect and expand the season strong. It is important to balance the relationship between the products in sales off-season and busy season, especially to determine the quantity of goods, the relationship between sales and pricing.

Gala goods relats to the major Chinese traditional festivals. Gala goods also has some characteristics, such as large profit space, short demand cycle, big demand in short term and smooth demand after the festival. It is often take a one-time order. The number of stock directly affects the sales profit, the rational and efficient demand forecasting leads to the correctness of the stock quantity.

Stochastic demand commodities' demand is random. Enterprises inevitably consider the influence of the dynamic changes of the demand and supply in setting inventory control strategy. The cases of uncertain demand are numerous , such as technical progress , product life cycle, the customer individuality demand and product research.

2.2. Replenishment strategy

According to the property of commodities, rice adopts (s,S) replenishment strategy. When the inventory (including pipeline inventory, the dotted line) at or below the s book is enough until the S, solid line as the net inventory, orders issued at A point in time, arriving time point B, L for lead time. The advantage of dynamic (s, S) inventory system replenishment strategy has been proved to have the minimum total cost of the optimal replenishment policy, which contains replenishment cost, holding cost and shortage cost and random demand. The defect is often need to solve the complicated nonlinear programming problem to get regional optimal solution rather than the global optimal solution. In order to solve this problem, this paper uses evolutionary algorithm to solve it, thus it can get the optimal solution. This paper uses genetic algorithm BP neural network to solving the optimal solution for S. The definitions of all variables are presented in Table 4.

Table 4. Notations

S	maximum inventory
A_r	the cost of the fixed replenishment
C_r	the unit cost of replenishment
A_d	fixed shipping cost
C_d	unit shipping costs
T	delivery cycle
h	unit holding cost
w	customer waiting costs per unit of time
λ	the demand for each cycle

Expect the average cost of inventory management (expected total cost) cycle:

$$E_{C(c,T)} = \frac{E(c)}{E(T)} \tag{1}$$

Objective function and constraint conditions as follows:

$$\begin{gathered} \min C(S,T) \\ s.t. S \geq 0 \\ T \geq 0 \\ C(S,T) = \frac{A_r \lambda}{\mathrm{S}} + C_r \lambda + \frac{\mathrm{h}\lambda\mathrm{T}(\mathrm{S}-1)}{\mathrm{S}} \\ + \frac{\mathrm{h}(\mathrm{S}-1)}{2} + \frac{A_d}{\mathrm{T}} + C_d \lambda + \frac{\mathrm{w}\lambda\mathrm{T}}{2} \end{gathered} \tag{2}$$

Each replenishment cycle expected replenishment cost:

$$E(C_r) = A_r + C_r \times \frac{S}{\lambda T} \times E[N(T)] \tag{3}$$

Each replenishment cycle expected shipping cost:

$$E(C_d) = A_d \times \frac{S}{\lambda T} + S_d \times \frac{Q}{\lambda T} \times E[N(T)] \tag{4}$$

Cost per customer wait for replenishment cycle:

$$E(C_w) = w \times \frac{RT^2}{2\lambda} \tag{5}$$

To explore the above set parameters on the minimum cost, the best inventory and the best delivery period, in this paper, the initial value sets as follows: Ar =65, h=7, Ad =15, Cr=1, Cd=1, w=15, T=3.5, The influence of various parameters on the results in Table 5.

Table 5. The experimental results

A_r	λ	h	A_d	w	s*	T*	C*
60	415	7	15	15	100.2	0.5030	4095.5
65	415	7	15	15	101.17	0.5019	4321.4
70	415	7	15	15	104.9	0.5009	4295.8

65	400	7	15	15	104.56	0.5025	4139.3
65	430	7	15	15	161.31	0.5001	4083.2
65	415	6	15	15	103.57	0.5011	3903.2
65	415	8	15	15	128.1	0.6837	3634.3
65	415	7	13	15	160.98	0.5061	4627.9
65	415	7	17	15	101.96	0.5033	4271.8
65	415	7	15	13	100.6	0.5008	4037.6
65	415	7	15	17	114.5	0.5014	4549.1

From the above table 5,we can get the following conclusion: (1)with various parameters, respectively, the total cost will increase1;(2) the cost of the fixed replenishment effects less on the cycle, but effects the best inventory ;(3) the increase of demand makes the delivery cycles shorter , the total cost is higher and higher; (4) the increase of fixed shipping costs can make the delivery cycle spin ,waiting cost makes the delivery cycle shorten.

3. Conclusion

The paper using the cluster analysis to divide retail goods into 3 categories is efficient. In (s,S) replenishment strategy, it needs to solve the complicated nonlinear programming problem, are likely to get regional optimal solution rather than the global optimal solution, the genetic algorithm BP neural network makes up these defects. we first establish the function relation between the optimal inventory and the best delivery cycle, on this basis, using the neural network, genetic algorithms to optimization of objective function, through calculation and finally got the best delivery cycle and the optimal inventory under the required minimum total cost. Also constant value of the parameters, and thus determine different parameters for best delivery cycle, the influence of the inventory, the minimum total cost. we also found that various parameters have mutual influence between each other. Therefore, it is necessary to adopt the different replenishment strategy according to different products .

This paper just considers some of the small point, with the development of science and technology, the cluster analysis of the three major categories of commodities, in the future to study between different categories will be deepened, making between different goods classification management is more reasonable.At the same time, different prediction model will be used to study the different commodity demand forecast and sales forecast, so that enterprises can better grasp the market, predict market more accurately , and make the enterprise in the fierce competition. For replenishment way, the future will optimize the existing replenishment strategy, emerging replenishment model will also be born, as like collaborative replenishment policy. In general, the enterprise using these technologies to save the import time, resources and reduce the cost of inventory control.

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