A Study on Sales Patterns for Vegetable Products in Retail Stores

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Abstract

In fresh produce supermarkets, the shelf life of vegetable products is typically short, necessitating daily restocking based on historical sales data and the formulation of a rational pricing strategy to maximize the store's profits. This paper, based on sales data for vegetable products in a particular store from July 2020 to June 2023, employs various analytical methods, including multidimensional analysis, clustering, and regression, to explore the interrelationships among different types of vegetables. Furthermore, it combines cost-plus pricing and price elasticity models to establish a pricing framework that optimizes revenue for the supermarket.

Keywords: vegetables for sale, vegetable pairing, cost plus pricing, pricing strategy

1. Introduction

Nowadays, with the continuous improvement of people's living standards, fresh merchants are opening in various places. In the sale of vegetable commodities, because the fresh-keeping period of vegetable commodities is relatively short, and the product phase becomes worse with the increase of sales time, it is of great significance for merchants to replenish according to the historical sales and demand of various types of vegetables in the past.

In the actual operation of the store, the store should consider the types of various vegetables, origin, shelf life, purchase time, season, store space and other factors to reasonably replenish different vegetables. In addition, the store should also consider the consumption time of customers, the number of types of dishes, market conditions and other factors to determine the price. The research on reasonable replenishment and pricing of vegetables has important guiding significance for the sale of vegetables in real life.

This paper will explore the distribution of different vegetable sales from different dimensions, and combined with the cost plus pricing [1] and price elasticity model [2] to explore and set a set of pricing relationships to maximize the profits of supermarkets.

The rest of this paper is organized as follows. The second part studies the law of vegetable sales according to the data of previous years. Section III introduces the construction of the pricing model. In Section IV, the evaluation model and the obtained results are analyzed. Section 5 summarizes the main contents of this paper.

2. Rules of Vegetable Sales

The data statistics the flow details of vegetable products sold in a store from July 1, 2020, to June 30, 2023, which contains six vegetable categories and the corresponding single product sales volume and sales unit price. In the following, the sales rules of vegetables will be analyzed from three dimensions: quarterly, weekday and non-weekday, and freshness.

2.1. The quarterly factor

By summarizing the total sales volume of the six categories of goods in each quarter, the visualized data are presented in Fig.1.

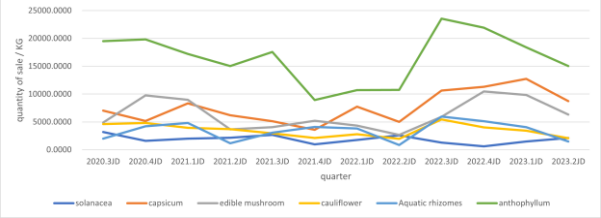

Fig.1. quarterly factor chart

As can be seen from the Fig.1, the sales volume of each vegetable category shows periodic changes over time. The sales volume of the third quarter of 2020, the third quarter of 2021 and the third quarter of 2022 to the third quarter of 2023 show the same trend. The trend between the third quarter of 2021-the third quarter of 2022 and the two cycles may be different because the COVID-19 pandemic has affected sales.

2.2. Working days and non-working days

In real life, people often have meals at work on weekdays and buy fewer vegetables every day. On non-working days, that is, Saturday and Sunday, people are more willing to buy more vegetables to eat. The average sales volume of six types of vegetables on weekdays and non-working days are shown in Fig.2.

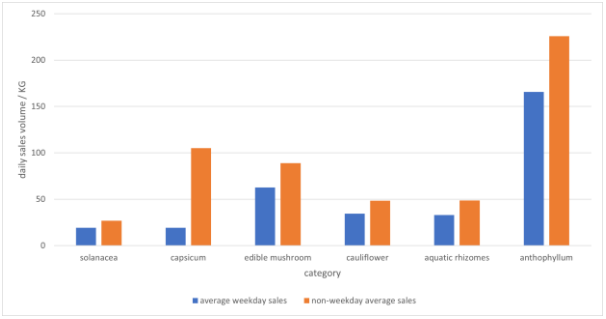

Fig.2. weekday and non-weekday factors

It can be seen from Fig.2 that each category sells well on Saturday and Sunday, and the sales volume is large, which reflects that the average sales volume of the six vegetable categories on non-working days is stronger than that on working days.

2.3. Freshness of vegetables

In a day, from morning to evening, the freshness of dishes gradually decreases. The average daily sales volume of the six vegetable categories is divided into three periods by time, and the sales volume of each vegetable category in the morning, middle and late periods is summed up, to analyze the distribution of the freshness of dishes in the store on the sales rule, The data are visualized in Fig.3.

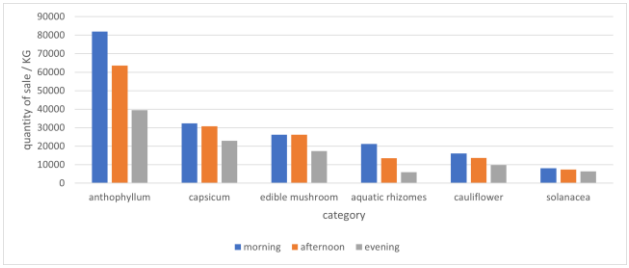

Fig.3. freshness factor map of vegetables

It can be seen from Fig.3 that the sales volume of all dishes is the largest in the morning, followed by the afternoon, and the least in the morning. This result is consistent with the actual life, and reminds the merchants to prepare all the goods in the morning, and carefully replenish the goods in the afternoon and evening.

2.4. The distribution law of sales volume of each single product

Each major category of vegetables contains a variety of single vegetable products. The single vegetable products are divided into 7 categories by K-means clustering

method [3], and the trend of the average sales volume of each category of single product over the quarter is drawn, which is shown in Fig.4.

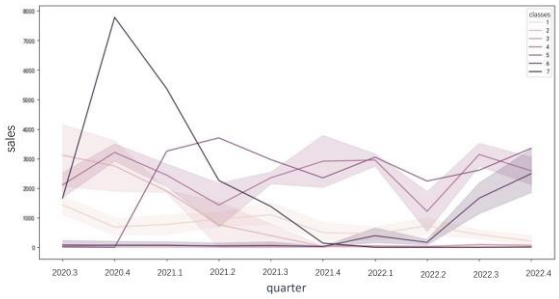

Fig.4. regular trend chart of single product sales

The average sales volume and sales volatility (standard deviation) of each category of single product are calculated, and combined with the quarterly sales trend of single product, the sales rule of single product is shown in Fig.5.

Category	Average Sales Volume/KG	Sales Volatility (Standard Deviation)	Quarterly Trend
First Category	About 663.58, at a medium level	About 529.82, relatively small	Sales volume is relatively stable, without obvious peaks or valleys
Second Category	About 754.04, also at a medium level	About 1211.53, high volatility	Sales volume has some fluctuations, with some seasonal effects
Third Category	About 54.89, significantly lower than other categories	About 88.17, lowest volatility	Sales volume is overall low and stable
Fourth Category	About 2278.61, significantly higher than other categories	About 858.75	There are several quarters with very high sales volume, possibly seasonal products
Fifth Category	About 2347.03, also a high sales volume category	About 1203.68, high volatility	Sales volume fluctuates greatly in different quarters
Sixth Category	About 739.19, at a medium level	About 1029.03, also high volatility	Sales volume has some fluctuations
Seventh Category	About 1598.93, high sales volume	About 2503.23, highest volatility	There are several quarters with very high sales volume, large seasonal impact

Fig.5. summary of single product sales rules

3. Building A Pricing Model

The purpose of establishing the pricing model is to maximize the profit obtained by the merchants [1]. Firstly, the purchase price and sales volume of each category of vegetables in the future should be predicted according to the previous data, and then the cost markup rate and elastic demand should be added for modeling.

3.1. Cost-plus pricing

Cost-plus pricing is a method to determine the price of a product based on the cost of the product, plus a certain profit margin [2]. This method is simple and easy to implement, which can ensure that the costs and profits of enterprises are compensated, and is also conducive to maintaining the stability of prices. The calculation formula of the cost-plus pricing method is as follows.

$$\text{Price} = \text{unit cost} + \text{unit cost} \times \text{cost margin} \quad (1)$$

3.2. Price elastic demand

Price elastic demand refers to the response degree of quantity demanded to price changes, which is usually expressed by the ratio of the percentage change in quantity demanded to the percentage change in price, that is, the price elasticity coefficient of demand.

3.3. Buildup of model

The impact of establishing the selling price and cost markup rate on sales volume for each vegetable category is as follows.

$$Q_i = \alpha_i + \beta_{1i}P_i + \beta_{2i}R_i + \epsilon_i \quad (2)$$

Here, α_i is the intercept term. β_{1i} and β_{2i} are the coefficients representing the influence of selling price P_i and cost markup rate $R_i$on sales volume Q_i, and ϵ_i is the error term.

The price elasticity, denoted as β_{2i}=E_i, is defined as:

$$E_i = \frac{\Delta Q_i/Q_i}{\Delta P_i/P_i} \quad (3)$$

To maximize the profit for supermarkets, we establish a constraint equation for profit Π.

$$\Pi = \left(P_i - C_i \times (1+L)\right) \times (E+1) \times D \quad (4)$$

Here, P_i is the selling price, C_i is the cost, L is the loss rate, E_i is the price elasticity's impact on sales volume, and D is the demand quantity.

4. Interpretation of Result

According to the above model construction, six types of vegetable commodity data are brought into the model and calculated with Python to obtain the final answer.

4.1. Evaluation of the model

Advantages:

(1) By comprehensively considering the relationship between sales volume, cost markup and price elastic demand, merchants can maximize profits. This comprehensive consideration can help merchants more comprehensively consider the impact of various factors when formulating pricing strategies.

(2) The use of historical data for forecasting can provide certain reference basis to help merchants make a reasonable estimate of future sales volume and purchase price.

(3) The cost-plus pricing method is simple and easy to implement and can ensure that the costs and profits of enterprises are compensated, which is conducive to the stability of prices.

(4) Considering price elastic demand, that is, the sensitivity of demand to price, can help merchants better understand the changes in market demand and make corresponding adjustments when setting prices.

Disadvantages:

(1) The model excludes the influence of special factors such as weather and source of goods, which may have an important impact on the sales volume and purchase price. Therefore, in practical applications, it may be necessary to further consider the influence of these factors.

(2) The model does not consider the pricing strategies of competitors and the impact of market changes, which may limit the applicability of the model in the real market environment.

5. Conclusion

Through THE ANALYSIS OF THE flow records of vegetable commodities in a store, the sales relationship between different vegetable categories is explored, and the basic pricing model is obtained, which makes the store maximize the profit, which will help the store replenishment and pricing.

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