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Research on accurate prediction of vegetable commodity pricing strategy and dynamic replenishment quantity based on optimization model

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Abstract

Based on the characteristics of timeliness, fast price change and easy loss, this paper deeply studies the automatic pricing and replenishment strategy of fresh suppliers, in order to maximize the profit of the supermarket. We propose and solve the number of related problems, and fit the linear and nonlinear models, and the results have limited effect. Therefore, this study translated the replenishment problem into sales volume prediction, using LSTM and predicting future sales by random forest model. At the same time, based on the periodicity of vegetable commodity sales, this study proposes the single product replenishment volume and pricing strategy. Finally, in view of the poor fitting effect of a single factor in this study, the improvement method of collecting data from multiple dimensions is proposed to deeply explore the relationship between replenishment and pricing, so as to improve the accuracy of prediction and supermarket revenue.

Keywords: optimization model, correlation, pricing, replenishment

I.INTRODUCTION

Fresh commodities and agricultural products, as an indispensable part of daily life, due to their unique difficult preservation, easy deterioration and high loss rate, have brought unprecedented challenges and uncertainties to the whole supply chain, especially the procurement link. This characteristic requires enterprises to have a high degree of sensitivity and flexibility in procurement, because any small procurement error may quickly translate into a large amount of loss of goods, and then into a heavy financial burden of the enterprise, affecting the profit space. Therefore, how to accurately control the procurement cost, scientific planning of the replenishment quantity, has become the core issue of continuous exploration and optimization of fresh distribution enterprises. In the face of the strong timeliness of fresh goods, enterprises should not only race against time to ensure that every link from the field to the consumers' table is shortened as far as possible, but also to cope with the challenge of rapidly changing market prices. Price fluctuations are often affected by multiple factors such as seasonal change, weather change and holiday demand surge, which makes predicting future price movements based on historical data particularly complex and critical. Fresh suppliers need to establish a set of efficient information collection and analysis system, real-time monitoring of market dynamics, in order to respond quickly, to make a reasonable pricing decision, not only to ensure the competitiveness of goods, but also to maintain enterprise profits.

In particular, vegetable commodities as an important part of the fresh market, its supply mode is more unique. Since vegetable picking and trading are mostly concentrated in the early hours, businesses must complete the precise preset of the replenishment quantity and pricing of each vegetable category the next day before night falls. This decision-making process not only tests the supply chain management ability of enterprises, but also requires the enterprise to have strong data analysis ability, to accurately predict market demand, balance inventory and sales, and avoid the loss caused by excess or shortage. In order to achieve this goal, fresh business super is actively seeking technical innovation and model upgrade, such as the introduction of intelligent prediction system, combined with historical sales data, weather forecast, holiday effect and other multi-dimensional information, automatically generate the optimal replenishment and pricing scheme. At the same time, strengthening the cooperation with upstream suppliers, establishing a stable supply relationship, to ensure sufficient supply of goods and reliable quality, is also an effective way to reduce procurement costs and reduce losses.

To sum up, the automatic pricing and replenishment decision of vegetable commodities is not only the key link for fresh suppliers to improve the operational efficiency and optimize the cost structure, but also an important means to maintain a leading position in the fierce market competition and realize sustainable development. With the progress of technology and the continuous maturity of the industry, we have reason to believe that more innovative solutions will emerge in this field to revolutionize the fresh distribution industry.

II.RELATED WORK

The price theory and pricing practice of vegetable production and marketing can be traced back to the 1980s. Xu Xuanfang proposed that urban vegetable production and supply is an old problem that has not been properly solved for a long time, and proposed that this problem should be solved gradually in accordance with the requirements of developing commodity economy in the reform of economic system . In 2010, Lu Yajie from Beijing Jiaotong University analyzed the research results of domestic and foreign scholars on the value loss and pricing of perishable products, summarized the current commonly used pricing methods for retail products, and analyzed the pricing trend of modern retail products.

In 2014, Hu You scholars verified the agricultural prices present obvious long-term trend and seasonal trend, short-term fluctuations frequently and tend to be intense, Xu Light scholars through HP filter analysis verified the agricultural price fluctuations mainly comes from long-term trend and seasonal changes, and vegetable prices affected by short-term irregular changes. In 2017, Li Jianping and other scholars obtained through the analysis of vegetable price data in Hebei Province that vegetable prices show the characteristics of wave movement trend and frequent price fluctuations and large fluctuation range.

In 2022, Mao Lisa in the perspective of supply chain vegetable wholesale market pricing strategy and production and marketing model research in combing, summarizes the agricultural price research at home and abroad, and from agricultural supply chain, agricultural product price prediction and price fluctuation factors analysis the three aspects of agricultural prices dynamic research at home and abroad,determine the fusion pull supply chain ideas, with consumer demand as the core, from the macro strategy analysis how vegetables scientific pricing.

In 2024, Zhao Jia conducted an optimization study on the pricing and replenishment decision of supermarket vegetables. By analyzing the distribution of vegetable sales over time, and using the Pearson coefficient and ARIMA model to predict the future trend of the price, it provided a scientific basis for the vegetable management of supermarket. Then, Wu Meng and other scholars, in the problem of "automatic pricing and replenishment decision of vegetable products", by stripping the time effect of sales volume, using the stochastic optimization method, and solved the replenishment and pricing strategies, providing a feasible solution for the daily operation of such products.

At the same time, Cao Yuxuan scholars (2024) is further discusses the vegetable commodity pricing and replenishment strategy, by processing the missing water data and outliers, the introduction of Prophet model analysis sales trend, combined with the simulation return algorithm and genetic algorithm to solve the optimal pricing and replenishment strategy, at the same time considering the factors such as inventory space and storage time. In the study of dynamic pricing and replenishment decision of vegetable commodities, Gao Jianan and other scholars (2024) analyzed the rules and connections of vegetable sales data through clustering algorithm and linear regression model, used the simulated return algorithm to solve the optimal replenishment and pricing strategy, and put forward a promotion sales strategy.

These studies have deeply discussed the pricing and replenishment decision of vegetable commodities from different perspectives and levels, and provided rich theoretical basis and practical guidance for the research and practice in related fields.

III.FUTHER ANALYSIS

In this study, the following four questions are raised and are analyzed in detail, so as to deeply study the automatic pricing and replenishment strategy of fresh supermarket, in order to maximize the revenue of supermarket. Meanwhile, in order to ensure the accurate solution of the problem, this study made a series of important assumptions based on the provided experimental data.

3. 1 Analysis of the correlation between vegetable sales characteristics and individual product

categories

According to the research orientation,it is imperative to seek the distribution characteristics of different categories and different single products of vegetable products according to the information of each commodity, analyze the difference degree or correlation between different whole categories of vegetable products or between different single products, so as to identify the sales trend or seasonality, and get the categories or single products with similar sales models. According to the sales, wholesale, loss and other information of each commodity, the average sales volume, median, variance and other data of each category and single product are calculated. The distribution pattern is expressed by the boxchart, so as to obtain the distribution characteristics of different categories and different single products of vegetable products. According to the descriptive statistical results obtained, the corresponding correlation analysis method is selected to quantify the difference degree or correlation between different categories of vegetable products or between different single products, so as to identify the sales trend or seasonality, and obtain the categories or single products with similar sales models.

3.2 Supermarket Revenue Optimization: Sales-Cost Forecasting & Strategy Planning"

The second goal is to maximize the revenue of the supermarket, and analyze the relationship between the total amount of sales and the cost plus pricing of each vegetable category, so as to predict the replenishment and pricing strategy in the next week. At the same time, based on relevant information extraction characteristics, build a regression prediction model for the vegetable category sales and cost plus pricing relationship, using linear planning model, with sales revenue minus cost and loss as the target function for the next week of the replenishment and pricing strategy, find the daily revenue corresponding sales and pricing, so that the business super maximum benefits.

3.3 Maximal revenue Strategy: Optimal Replenishment & Pricing via Pricing-Revenue Analysis

The third research direction by analyzing the sales of the relationship between pricing and revenue, and based on the regression prediction model, previous gaol to super revenue maximization as the target function, according to the constraints of the topic of the target planning model obtains the optimal solution, find on July 1, the corresponding optimal item replenishment and pricing strategy.

3.4 Vegetable replenishment pricing optimization: data-driven profit improvement

The last idea of the project is to optimize the target function based on the known and other relevant variables to be tested, that is, to predict the more appropriate replenishment and pricing volume to achieve higher returns. According to the existing data, the problem solving process of the model analysis results and find the data, to determine the current vegetable commodity replenishment and pricing decisions, find other related factors, to fresh super automatic pricing and replenishment decisions for the future business to find more optimized complete solution, finally achieve the goal of maximizing profits.

IV.EMPIRICAL ANALYSIS

4.1 The assumptions of the model

In constructing a model based on the provision of experimental data, this study follows a series of core assumptions to ensure the rationality, accuracy and reliability of the analysis. First, this study ensures that all the recorded data provided are authentic, accurate and effective, which is the cornerstone of analysis;although it is acknowledged that some abnormal or missing values may be due to human factors during data entry, these conditions are considered as acceptable error ranges and will be appropriately considered and corrected in subsequent processing. Secondly, this study assumes that during the time period of data coverage, the market environment remains stable without experiencing any significant abnormal fluctuations, so that the sales data can reflect a relatively stable market trend. This assumption is an important prerequisite for analyzing the variation law of sales data.

At the same time, this study assumes that there is a direct correlation between sales volume and price: the increase in commodity pricing tends to lead to a corresponding decrease in sales volume; otherwise, the lower pricing may stimulate sales growth. This assumption is based on the principle of supply and demand in economics, and it is an important basis for predicting and optimizing the pricing strategy. In terms of inventory management, the research assumes that the vegetables purchased daily can be sold at normal prices, or sold at a discounted price in case of transportation loss or appearance change. This means that the purchase volume and sales volume are balanced, and there is no sales impossible due to the loss of goods, thus simplifying the complexity of inventory management.

In addition, for the problem of loss rate, this study assumes that the loss rate of each item has stabilized after July 2020, and the recent loss rate data of each product are also applicable to the loss rate forecast corresponding to the item from July 2020 to June 2023. This assumption provides evidence for the assessment and control of attrition costs over a longer time span. Finally, in order to simplify the analysis process and enhance the applicability of the model, we assume that the loss rate of each category can be approximated by calculating the average of the loss rate of all items in that category. This method not only takes into account the differences within the category, but also facilitates the rapid estimation and prediction of the loss cost in practice.

In conclusion, the above hypotheses together constitute the theoretical framework for building the model and analyzing the data in this study, aiming to ensure the accuracy and practicality of the analytical results.

4.2 Symbol description

symbol	meaning
a	Supplemental quantity
b	quantity of sale
c	ullage

4.3 Analysis of Vegetable Sales Models: Seasonal Trends and Differences, Supporting

Accurate Decision Making

4.3. 1 Preprocessing of the data

In the data preprocessing phase, the first priority is to refine and divide the dataset. Specifically, based on the coding information, this study supplemented the missing category and single variety class information to ensure the integrity and accuracy of the data. Subsequently, based on the "category" as the division, this paper subdivides the data set into six different categories, with each category containing its own sales information. This purpose is to facilitate the subsequent in-depth analysis of different categories. In order to improve the efficiency and accuracy of data processing, the elimination of invalid data is also an important part of it. According to the title requirements, the record of "Sales Type" marked as "Return" and the data with problems in the single item coding were identified and removed from the data set. This step effectively reduces the noise in the data and lays a solid foundation for the subsequent analysis.

Finally, in order to further optimize the data and facilitate the analysis of the correlation between categories or items, the variable of "code scanning sales time" was discretized. The specific method is to map the continuous sales time interval (e. g. 2:00 -3:00) to discrete time points (such as 2), and similarly, the sales time interval of 18:00 -19:00 is uniformly recorded as 18. This treatment makes the sales time data more concise and clear, which is convenient to apply the statistical analysis method in the follow-up analysis to explore the impact of sales time on the sales of category or single product.

4.3.2 Data analysis and rule exploration

In the distribution pattern of vegetable sales of each category and single product, let's first check the sales situation of all kinds of vegetables, and we can get the following figure:

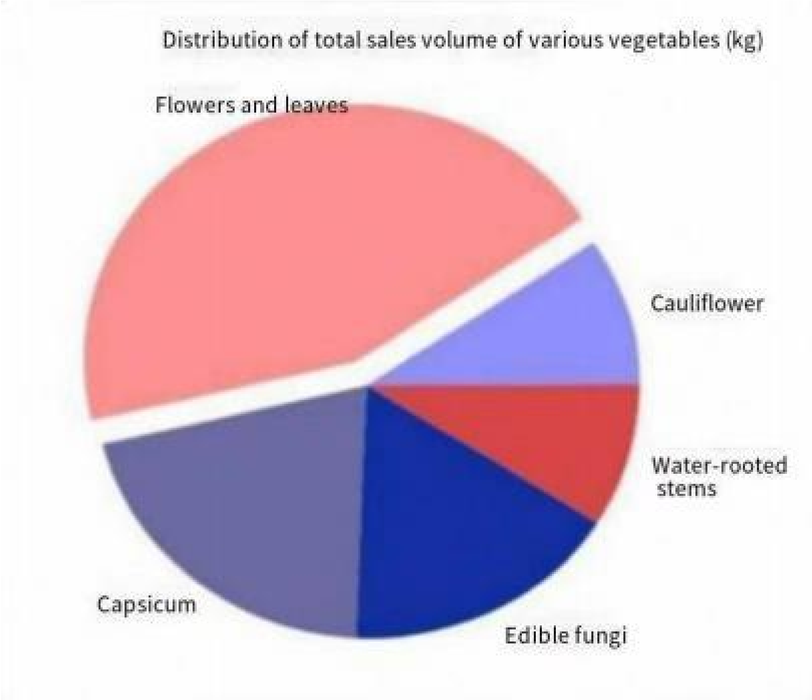

Figure 1 Distribution chart of the total sales volume of various vegetables

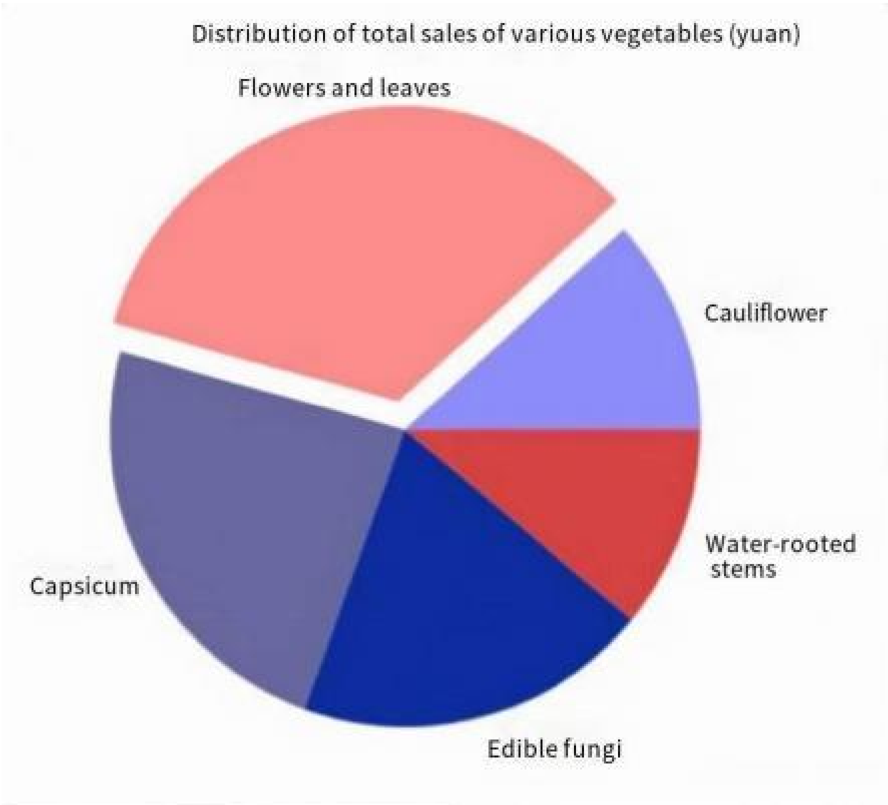

Figure 2 Distribution chart of the total sales volume of various vegetables

According to the analysis from the chart, the distribution proportion of mosaic vegetables is the highest in both sales and sales.

First of all, according to the frequency of each time period, the peak sales is concentrated between 9:00 and 10:00 am, accounting for about 35% of the total sales day, in line with the peak time of category sales.

frequency

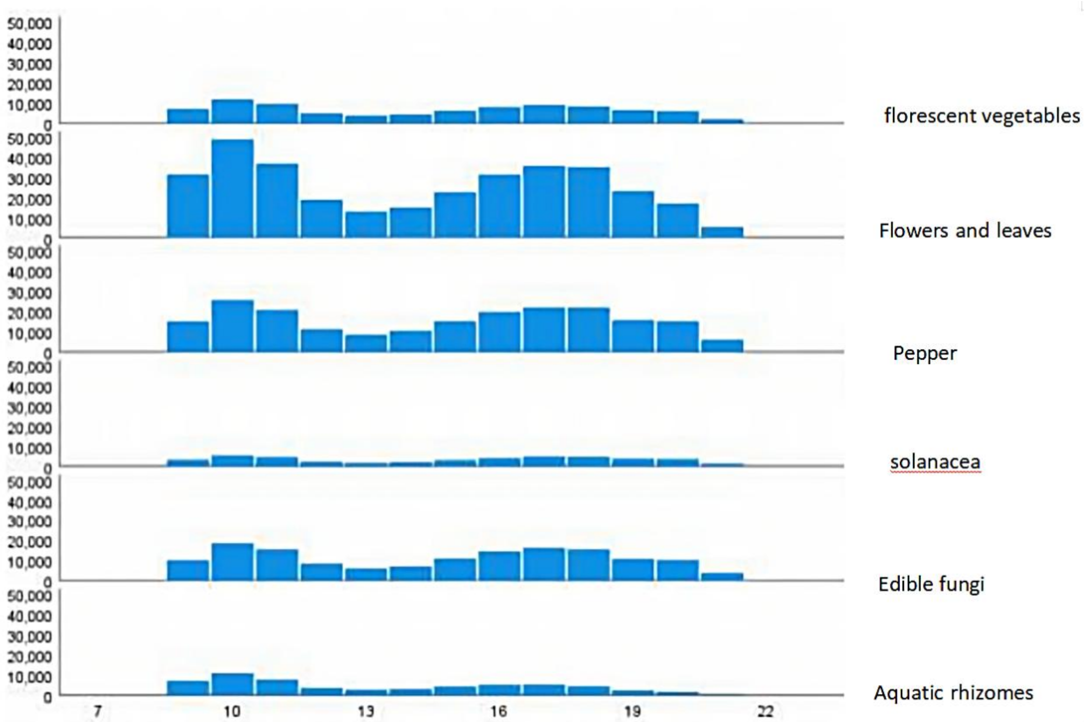

Figure 3 Histogram of the sales time distribution of various types of vegetables

As shown in the figure, we can see that the sales time of each category does not follow the normal distribution. Since the sample size of each category was> 5000, Kolmogorov Smirnov method was used to test the sales time for normality. The ks value of the six categories were between 0. 1 and 0.2, and the p value was <0.5, so the data did not meet the normal distribution.

Secondly, the relationship between the sales time and the return sales volume is analyzed. The total amount of returns in the same time period within each data set was calculated, and the two variables were analyzed using the correlation test. Due to the large number of samples and no normal distribution, the spearman correlation analysis was used.

Table 1 6 Results of spearman correlation analysis between sales time and return volume of various categories

	Aquatic rhizomes	Flower vegetables	Flowers and leaves	Pepper class	edible fungi	Solanum
correlation	0.121	-0.3	-0.014	-0.291	-0.236	-0.321

p price	0.694	0.370	0.960	0.334	0.437	0.365

According to Table 1, there is a statistically significant relationship between sales time and return volume for all categories. Only aquatic rhizomes showed positively correlation, with the strongest correlation.

4.4 Optimization of vegetable sales strategy under category segmentation: replenishment and

pricing simulation based on historical data

4.4.1 Division of the data sets

In the relationship between the total sales of vegetables and the cost plus pricing of each vegetable category, this study first takes the aquatic roots as an example to count the average sales volume, the total sales volume, the average sales price, the average sales value and the total sales volume quarterly, and the statistical chart of their quarterly changes is drawn as follows:

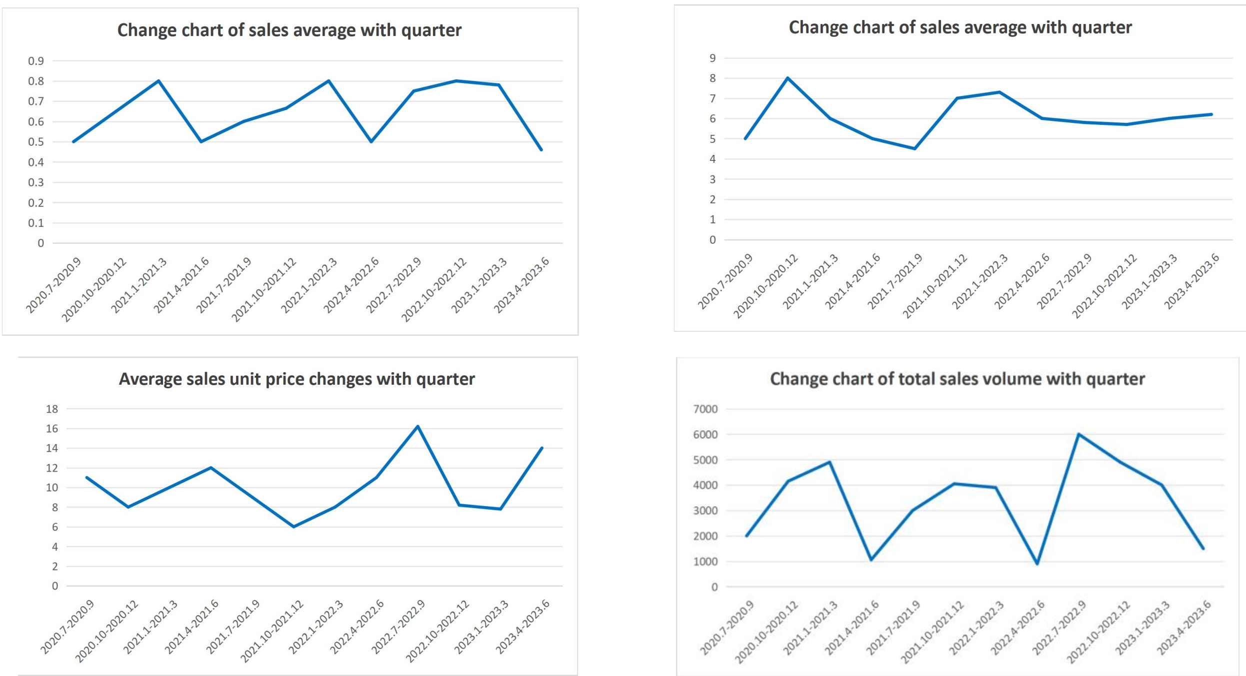

Figure 4 Figure of sales volume and sales of aquatic rhizome from quarter to quarter

It can be found from the figure that there are more obvious seasonal changes phenomenon. Therefore, use the quarterly average pricing of each category to reflect the selling price. Supermarket usually sells the goods with transport loss and product phase difference at a discount. Combined with the data of "whether or not", this paper believes that the cost plus pricing is the selling price in the normal sale state, and the average loss rate is reflected in the goods sold at a discount. Remove the "discount" sample of the "discount sales" column, and obtain the average quarterly pricing and total sales in each category.

4.4.2 Linear regression fit

The linear regression is used to predict the relationship between the average pricing and the total sales volume of each category. Results are shown in the following below:

Linear regression analysis n=12									
	Non-normalized coefficient		Normalization factor	t	p	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	11.151	1.429	-	7.805	0.000***	-	0.159	0.075	F=1.895 P=0.199
Cauliflower sales	-0.001	0	-0.399	-1.377	0.199	1			
Dependent variable:average unit price of cauliflower									

Linear regression analysis n=12									
	Non-normalized coefficient		Normalization factor	t	p	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	12.468	3.2	-	3.896	0.003***	-	0.049	-0.046	F=0.513 P=0.490
Pepper sales	0	0	-0.221	-0.716	0.490	1			
Dependent variable:average unit price of pepper									

Linear regression analysis n=12									
	Non-normalized coefficient		Normalization factor	t	p	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	7.858	1.157	-	6.789	0.000***	-	0.17	0.087	F=2.046 P=0.183
Sales of flowers and leaves	0	0	-0.412	-1.43	0.183	1			
Dependent variable:average unit price of flowers and leaves									

Linear regression analysis n=12									
	Non-normalized coefficient		Normalization factor	t	p	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	0.568	0.123	-	4.627	0.001***	-	0.036	-0.06	F=0.377 P=0.553
Sales volume of edible fungi	0	0	-0.191	-0.614	0.553	1			
Dependent variable:average unit price of edible fungi									

Linear regression analysis n=12									
	Non-normalized coefficient		Normalization factor	t	p	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	8.647	0.702	-	12.318	0.000***	-	0.001	-0.099	F=0.01 P=0.921
Sales volume of seedlings	0	0	0.032	0.102	0.921	1			
Dependent variable:average unit price of seedlings									

Linear regression analysis n=12									
	Non-normalized coefficient		Normalization factor	t	p	VIF	R^2	Adjusted R^2	F
	B	Standard error	Beta						
Constant	14.004	1.633	-	8.575	0.000***	-	0.381	-0.319	F=6.158 P=0.032**
Unnamed:11	-0.001	0	-0.617	-2.482	0.032**	1			
Dependent variable:Unnamed:10									

Figure 5 fits the results of average pricing and total sales volume in each category by linear

By analyzing the F value, whether it can significantly reject the null hypothesis of an overall regression coefficient of 0 (P <0.05), indicating a linear relationship. From Figure 5, only the aquatic rhizoids have a linear relationship y = 0.001 sales volume + 14.004. According to R2 = 0.381, the model can be simulated poorly, while β 1 = 0.001 has little effect on pricing and is negligible. Therefore, the linear relationship between the average pricing and the total sales volume of the six categories almost never exists.

4.4.3 with a nonlinear regression fit

	MSE	RMSE	MAE	MAPE	R^2
Training set	3.027	1.74	1.346	14.69	-0.331
Test set	3.261	1.805	1.555	17.102	-0.692

Figure 6 fits the relationship between average unit price and sales volume using SVR

	MSE	RMSE	MAE	MAPE	R^2
Training set	0.693	0.833	0.677	10.325	-0.333
Test set	4.781	2.187	1.875	25.601	-5.041

Figure 7 The results of the relationship between average unit price and sales volume using bp neural network

In the case of mosaic class, the relationship between average unit price and sales volume was fitted using two nonlinear fitting methods SVR and bp neural network, but both results were bad, and a negative R2 appeared. There are many reasons for this situation. According to the background, there are many conditions affecting sales, such as holidays, weather, etc., these factors can not be captured, resulting in a low degree of fitting.

4.4.4 Research on daily replenishment volume and pricing strategy

In order to maximize the supermarket revenue, the most important thing is the balance between supply and demand, so the total daily replenishment volume is equal to the daily sales volume, and the problem turns into predicting the daily sales volume and pricing in the coming week. Based on the daily sales of each category in the last 30 days, the daily sales are predicted using the LSTM model. The objective function is obtained from the average loss rate and purchase price of Annex 4. Training the LSTM model as the penalty function gives the following results:

Pepper class

```
[[6.9523115]
 [7.017157 ]
 [7.0006223]
 [7.072486 ]
 [7.0653434]
 [7.0792665]
 [7.075546 ]
 [7.0149417]
 [7.035147 ]]
```

Flowers and leaves

```
[[5.6240015]
 [5.6278706]
 [5.616742 ]
 [5.5314236]
 [5.4018893]
 [5.5747232]
 [5.5798473]
 [5.587686 ]
 [5.580325 ]]
```

Edible fungi

```
[[10.89376 ]
 [11.229065]
 [11.214216]
 [11.437225]
 [11.450091]
 [11.481675]
 [11.014762]
 [11.138902]
 [11.391297]]
```

Solanum

```
[[8.204604 ]
 [8.204604 ]
 [8.219655 ]
 [8.4133215]
 [8.876253 ]
 [8.917852 ]
 [8.97417  ]
 [8.688676 ]
 [8.796709 ]]
```

Flower vegetables

```
[[14.546509]
 [13.989865]
 [14.335843]
 [14.23504 ]
 [13.663712]
 [14.501285]
 [14.538223]
 [14.493708]
 [14.455106]]
```

Aquatic root stem

```
[[15.095946]
 [15.204161]
 [15.215056]
 [15.214834]
 [15.007731]
 [15.214899]
 [15.210695]
 [15.16814 ]
 [15.198438]]
```

Sales were predicted over the next seven days using a random forest-based regression model RandomForestRegressor. Results are shown in the following below:

Edible fungi:
Sales forecast for the next 7 days: [39.00165 28.02053 33.33856 33.75891 49.33046 67.7692 27.44323]

Solanum:
Sales forecast for the next 7 days:[270.96543 57.92693 200.46825 73.24626 29.44472 169.88678 32.14159]

Chili:
Sales forecast for the next 7 days:[73.55937 75.79715 77.97962 74.60198 75.95377 79.19769 86.83026]

Flower vegetables:
Sales forecast for the next 7 days : [9.60988 15.11785 19.96429 15.5934 12.74027 23.0452 16.93704]

Aquatic rhizomes:
Sales forecast for the next 7 days:[16.62478 29.50581 10.87869 29.50581 13.42484 16.85417 22.05812]

Flowers and leaves:
Sales forecast for the next 7 days:[141.84129 139.87667 139.87667 127.62942 95.56486 122.66788 95.56486]

Figure 8 7-day sales forecast value for different categories

Because the regression prediction is based on the data of nearly 30 days, even if the sales volume and selling price will be obviously affected by the season, it is generally consistent with the size and trend of the historical data.

4.5 Single item sales optimization strategy: Analyze the optimal replenishment quantity and

pricing on July 1st to achieve maximum revenue for supermarkets

4.5. 1 Preprocessing of the data

In the fresh supermarket, the sale of general vegetable commodities has a cyclical pattern. Therefore, the sales situation of vegetables in adjacent two weeks is similar, based on the available varieties on June 24 -30, 2023, the replenishment quantity of single product on July 1 is given. First, read the sales data on June 24 -30,2023 and save it to the new table, named "Seven-day Sales Table", and then obtain the sales volume of each item on each day during June 24 -30,2023 and the sales volume of all the items in the seven days.

4.5.2 Exploration on the replenishment quantity and price strategy of single products on July 1st

In the fresh food supermarket, the general vegetable commodities have a cyclical pattern. The sales situation of vegetables in the adjacent two weeks is similar, so the sales situation on July 1,2023 should be similar to the sales situation on June 24,2023. Select a total of 33 kinds of items sold on June 24,2023, and find out 26 kinds of items sold in 2.5kg, then all these items should be replenished, and the replenishment quantity A is

$$a = \frac{b}{1-c}$$

B is the sales volume and c is the loss rate. These 26 prices are all 24 —— 30 in June 2023, and the average unit price with the highest sales during the daily period (keep one decimal place).

Next, we need to find out whether the remaining six categories on June 24,2023 are worth replenishment. Their selling price is set as the daily average price of the highest sales of each item within 7 days before July 1,2023, and the replenishment volume A is

$$a = \frac{b}{1-c}$$

Where the b=2.5kg. From this we can get the final replenishment and pricing strategy for July 1 .

4.6 Comprehensive Strategies for Optimizing Vegetable Commodity Replenishment and

Pricing in Supermarkets"

In order to better make the replenishment and pricing decisions of vegetable commodities, in addition to considering the sales volume, sales unit price and damage rate, the supermarket also needs to understand:

1. Unold goods, because the wastage goods may be discounted or not sold.

Opinion: Introduction of cold chain preservation technology

Reason: The standardization level of agricultural products circulation in China is low, which makes the circulation loss relatively large [1]. At this time, the introduction of cold chain preservation technology can reduce the transport loss and product phase difference of goods, reduce the loss rate, and also increase the cost of goods. Collect data on additional costs and new loss rate generated by daily cold chain transportation over a period of time, analyze the relationship between sales volume and cost plus pricing, so as to obtain new commodity replenishment and pricing strategies.

2. Market environment factors, including whether there are adjacent supermarkets that have competing relationships, whether they are impacted by online platforms, etc. This will have an impact on the sales of the fresh supermarket, accordingly, the replenishment and pricing will also have fluctuations.

Opinion: Conduct market research.

Reason: According to the market research results, we can understand the affected category or single product of the supermarket vegetable product, the affected degree of it, and judge the positive or negative impact. In this way, we can adjust the replenishment and pricing of each vegetable category or single product, so as to ensure the income of the fresh supermarket.

3. Consumer evaluation and feedback.

Opinion: Conduct consumer demand research.

Reason: there is a substitution relationship between the same category, some vegetables are affected by the environment shortage or price increase, consumers will tend to buy similar goods to supplement the choice may change; some vegetables are affected by geography, theory, advertising and season, the demand will fluctuate over time, which requires different replenishment and pricing strategies.

Besides the above three points, Supply-chain data, Including seasonal items, delivery time and delivery costs will also have a cyclical impact on supermarket replenishment and pricing; The impact of emergencies on the price and supply and demand should not be underestimated [2], Such as the outbreak of COVID-19 in 2020; sales section, The price formation of vegetable commodities is mainly affected by consumption elasticity [3], consumer purchasing ability, economic development status, residents' income level [4], substitute price [5], price support policy [6], The economic environment will necessarily change consumer behavior, So that the fresh supplier can change the replenishment and pricing of vegetable commodities.

IV.CONCLUSION

After in-depth discussion of the pricing strategy of vegetable commodities and the accurate prediction of dynamic replenishment volume, this paper draws a series of important conclusions. These conclusions not only provide a theoretical basis for the optimization of retail industry, especially fresh e-commerce and supermarkets in vegetable management, but also point out the direction for the strategy adjustment in actual operation. The following is a detailed summary of the conclusions of this study.

5.1 Multi-dimensional consideration of the pricing strategy of vegetable commodities

5. 1. 1 Balance between cost orientation and market sensitivity

The research points out that the pricing of vegetable commodities should comprehensively consider the production cost, transportation cost, loss cost and market supply and demand changes. On the basis of cost, flexible price adjustment to reflect market fluctuations can not only ensure business profits, but also meet consumers' demand for price sensitivity. For example, during seasonal supply peaks, promote price reduction to quickly turnover inventory and reduce losses; when supply is tight, raise price moderately to cover costs and obtain reasonable profits.

5. 1.2 The application of differentiated pricing strategies

Differentiating pricing strategies are implemented for vegetables of different quality, varieties and consumer groups. High quality, organic or characteristic vegetables can target high-end market and adopt high price strategy; while ordinary vegetables attract public consumers through cost performance advantage. In addition, big data is used to analyze consumer purchasing behavior, provide personalized pricing solutions for customers with different consumption habits, and enhance customer stickiness.

5. 1.3 Strategic arrangement of promotional activities

The study found that reasonable promotion activities can effectively improve the sales of vegetables, but it is necessary to pay attention to the control of the frequency and intensity of promotion, to avoid the damage to the brand image and profit decline caused by excessive promotion. Through bundling sales, full reduction discount, member exclusive benefits and other ways, it can not only stimulate consumption, but also improve customer satisfaction and loyalty.

5.2 Key elements for the accurate prediction of the dynamic replenishment volume

5.2. 1 Data-driven prediction model: Use big data and artificial intelligence technology to build a multi-dimensional input prediction model based on historical sales data, weather changes and holiday factors, so as to achieve accurate prediction of vegetable replenishment volume. This model can capture market changes in real time, adjust replenishment plans in advance, and reduce the risk of overstocking and shortages.

5.2.2 Supply chain coordination and information sharing: Strengthening the cooperation between the upstream and downstream of the supply chain and realizing information sharing is the key to improve the accuracy of replenishment. By establishing close cooperation relationship with suppliers, timely obtain supply information and adjust procurement plan; meanwhile, maintain close communication with stores to understand sales trends and ensure that the replenishment volume matches the market demand.

5.2.3 Flexible response to emergencies: The vegetable market is greatly affected by the weather, epidemic situation and other emergencies. Therefore, it is very important to establish a rapid response mechanism and flexibly adjust the replenishment strategy. Through real-time monitoring of market dynamics, timely adjustment of prediction model parameters, to ensure that emergencies can respond quickly and reduce losses.

5.3 Comprehensive strategy optimization and future outlook

5.3. 1 Comprehensive pricing and replenishment strategy

The pricing strategy is combined with the replenishment volume forecast to form a comprehensive operation and management strategy. By optimizing the pricing strategy, guide consumer demand and reduce inventory backlog, and use accurate replenishment forecast to ensure adequate supply of goods and improve customer satisfaction. This integrated strategy helps to improve the overall operational efficiency and market competitiveness.

5.3.2 Technological innovation and digital transformation

With the continuous development of science and technology, the pricing and replenishment management of vegetable commodities in the future will be more dependent on technological innovation and digital transformation. Through the introduction of more advanced prediction algorithms, Internet of Things technology, blockchain, etc., the transparency and intelligent management of the supply chain is realized, and the efficiency and accuracy of management are further improved.

5.3.3 Sustainable development and social responsibility

While pursuing economic benefits, enterprises should also pay attention to sustainable development and social responsibility. Through the promotion of green procurement, reduce packaging waste, support local farmers and other measures, to achieve a win-win economic benefits and social benefits. At the same time, we will actively participate in social public welfare activities to enhance the brand image and social recognition.

To sum up, the pricing strategy and accurate prediction of dynamic replenishment volume of vegetable commodities are of great significance for improving the operational efficiency and market competitiveness of the retail industry. Through the comprehensive use of cost-oriented, differentiated pricing, data-driven prediction model and other strategies, combined with supply chain collaboration, technological innovation and social responsibility and other elements, enterprises can achieve more accurate and efficient operation management, and provide consumers with more high-quality and convenient shopping experience.

Vi. MODEL GENERALIZATION AND OUTLOOK

6.1 Model extension and policy suggestions

After in-depth discussion of the mathematical model of vegetable commodity replenishment and pricing decision, this model not only provides scientific pricing and replenishment strategy for supermarkets, but also lays a theoretical foundation for improving the overall income. In order to further apply this model to practice, significantly improve the efficiency and competitiveness of the supermarket and even the whole vegetable industry, and meet the high requirements of consumers for the freshness, taste and quality of vegetables, a series of comprehensive policy suggestions are particularly necessary.

First, the government should focus on the enhanced application and cost control of the preservation technology. Through policy incentives, such as subsidy mechanism and preferential tax policies, supermarkets are encouraged to adopt advanced technologies such as cold chain logistics, intelligent temperature-controlled storage system and biological preservative to effectively reduce the loss rate of vegetables in the circulation link. At the same time, it will promote the deep cooperation between scientific research institutions and enterprises, constantly research and develop economic and efficient preservation programs, and form the industry demonstration effect through the government promotion plan to accelerate the popularization of preservation technology. Secondly, improving the supply chain data collection and analysis system is the key to improve the accuracy of decision-making. The government should promote the establishment of a vegetable supply chain information sharing platform, realize the interconnection of data in all links, rely on big data analysis technology, and track market supply and demand, price trends and consumer preference changes in real time, so as to provide strong data support for supermarkets. In this process, it is necessary to strengthen data security and privacy protection to ensure the legitimacy and security of information circulation. Moreover, differentiated pricing strategies are implemented to adapt to the changeable market environment. The government should guide supermarkets to flexibly adjust the pricing price according to the differences in vegetable varieties, season, quality and consumer demand, use the price leverage to balance the supply and demand relationship, and avoid resource waste and price war. At the same time, we will strengthen price supervision, maintain market order, and protect the rights and interests of consumers.

In addition, the construction of market monitoring and early warning mechanism should be strengthened, the dynamic changes of key links should be monitored in real time, and the vegetable price index and market analysis reports should be regularly released to provide scientific pricing reference for supermarkets. In special periods, such as natural disasters or epidemic outbreaks, the emergency response mechanism should be launched quickly to stabilize market prices by means of reserves and subsidy policies, and ensure the continuity and stability of vegetable supply. Finally, promoting industry standardization and brand building is a long-term plan to realize the high-quality development of vegetable industry. The government should formulate and implement unified quality, packaging and transportation standards to enhance the overall quality and market competitiveness of vegetable products. At the same time, supermarkets are encouraged to establish their own brands, enhance the added value of products through brand operation, and enhance the market influence. The government can provide brand registration, publicity and promotion to help the vegetable industry develop in the direction of branding and high-end.

To sum up, comprehensive measures can not only effectively promote and apply the vegetable pricing model, but also comprehensively improve the operation efficiency and market competitiveness of the vegetable industry, meet the growing demand of consumers for high-quality vegetables, and realize the sustainable development of the industry.

6.2 Direction outlook

Looking into the future development of the vegetable pricing and replenishment model, we can clearly identify several major trends. First, intelligence and automation will be the main driving force of industry change. With the continuous maturity and popularization of cutting-edge technologies such as the Internet of Things and artificial intelligence, the supermarket will be able to use intelligent sensors to capture inventory changes, sales dynamics and consumer behavior data in real time, and then rely on advanced algorithms to automatically optimize pricing strategies and replenishment plans through the prediction model. This process will greatly improve operational efficiency, achieve precision marketing, and ensure that the product always meet market demand. Secondly, customized and personalized services will become the new normal of vegetable sales. In today's increasingly diversified consumer demands, supermarkets need to make full use of big data analysis technology, deeply dig into consumer preferences, and customize vegetable packages or provide personalized services for different consumer groups. This consumer-centered business model can not only enhance customer loyalty, but also significantly improve the consumption experience, bringing more stable customers to the supermarket.

Moreover, sustainable development and green supply chain will become the indispensable development direction of the vegetable industry. In the face of global environmental protection challenges and social responsibility requirements, the supermarket must actively build a low-carbon, environmentally friendly and sustainable supply chain system. This includes promoting the use of biodegradable packaging materials, optimizing logistics networks to reduce the carbon footprint, and implementing energy conservation and emission reduction measures across the supply chain. Through these efforts, the supermarket can not only fulfill its social responsibilities, but also establish a good image in the hearts of consumers and win more market share.Finally, cross-border e-commerce and international cooperation will open up new growth points for vegetable sales. With the rapid development of cross-border e-commerce platforms and the continuous reduction of international trade barriers, supermarkets have the opportunity to bring high-quality vegetable products to the global market. At the same time, strengthening exchanges and cooperation with international counterparts will help to introduce advanced management experience and technical means, enhance the overall competitiveness, and jointly promote the prosperity and development of the global vegetable industry. To sum up, the future development of vegetable pricing and replenishment model will present a diversified trend of intelligence, customization, green and internationalization.

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