Research on Material Planning for Automotive Parts Production

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Abstract. In recent years, with the continuous growth of China's economy and the increasing consumption power of people, the rapid development of the automotive industry has been promoted, and China has become the world's largest producer and seller of automobiles. In addition, with the increasing strength of China's opening up to the outside world, more and more foreign automobile manufacturing companies have entered China, leading to the gradual saturation of China's automobile industry. Many automotive R&D departments tend to develop the use of mid to high end raw materials, and the suppliers who own these raw materials are often large suppliers. For some enterprises with smaller demand, it is difficult to maintain good relationships with large suppliers, and the difficulty of supplier control increases. The automotive industry has become saturated in recent years, there are also issues with material planning for the emerging new energy vehicle manufacturing industry. Therefore, it is hoped that through the research in this article, inspiration can be provided for both traditional and new energy vehicle manufacturing industries to continuously improve the accuracy of material planning and demand forecasting, optimize inventory levels, reduce the impact of material supply uncertainty on enterprises, lower the capital occupied by inventory, improve capital turnover, and enhance the operational efficiency of the supply chain.

Keywords: Material Planning; Demand Forecasting; Stagnant Material.

1. Current Situation of Material Planning in Company A

1.1 Product Characteristics

The raw materials of Company A mainly include terminals, sealing plugs, connectors, cables, etc., mainly plastic parts. Each type of raw material has different models and specifications, but plastic parts such as terminals and connectors can be shared by plugging holes. Sometimes, when the materials cannot keep up and face downtime, this method can be used to temporarily solve the downtime problem. The main features of Company A's products are as follows:

1. The raw material has a small volume but a large quantity.
2. There are many types of raw materials, and the MOQ and SPQ ordered are large.
3. Raw materials of the same type have a certain degree of substitutability.
4. Raw materials have lower requirements for storage conditions, with fewer requiring special conditions for preservation. They can usually be stored under normal conditions and have an average storage time of over 3 years.

1.2 Current Situation of Material Planning

Currently, Company A has a total of 12 material planners, 6 production planners, 1 transportation administrator, 1 customs administrator, 1 lean administrator, and 1 warehouse administrator. Out of the 12 material planners, 2 are specifically responsible for following up on new projects. The new project is mainly divided into four stages: TT, PP, MP1, SOP stage; During the TT and PP phases, the project will be followed up by a dedicated planner responsible for the new project. When the project reaches the MP1 phase, it will be handed over to other planners for follow-up.

At present, material planners in Company A use the SAP system to view weekly and future demand forecasts, and also place orders with suppliers through SAP and EDI systems. For suppliers who have established long-term stable cooperation, orders will be placed through the EDI system. For new suppliers, the material planner will issue the EXCEL version of the current week's orders and future forecast information every Monday; Suppliers will refer to the future forecast for stocking, and if

there is a decrease in demand in the later stage, Company A will be responsible for absorbing 12% of E&O.

For material planning, the planner mainly places orders with suppliers based on the requirements provided by the SAP system. In the SAP system, the center will maintain information such as SPQ, MOQ, LT, GR, etc[1]. Every Saturday, PP will import the next week's demand into the SAP system. This way, MP can see the demand for the current week when placing an order on Monday. After these information are maintained in the system, the system will automatically generate a Schedule Line based on the demand. Then the planner can refer to the Schedule Line to generate orders.

However, the schedule line generated by the system is very rigid, and for some special cases, the recommended schedule line by the system is unreasonable[2]. For example, when the center is unable to maintain master data information in a timely manner or when master data information needs to be changed, the planner will decide on their own how to place orders with suppliers based on the actual situation.

1.3 Analysis of Material Planning Issues in Company A

1. Inaccurate demand forecasting

When significant fluctuations occur, due to the lack of prior knowledge from material planners and production planners, there may be material shortages when demand suddenly increases. At this time, material planners will choose to expedite delivery, resulting in higher air freight costs; When demand suddenly decreases, it can lead to inventory backlog, production staff being forced to rest, and production line shutdowns. The fluctuation of demand and inaccurate forecasting are important factors affecting the development of Company A. Requirements are related to various aspects of material planning, production scheduling, and inventory management. If the accuracy of demand forecasting can be improved, it can greatly reduce the logistics and labor costs of Company A, while also improving work efficiency and avoiding resource waste.

2. Difficulty in controlling suppliers and delayed delivery

For the material planner of Company A, controlling suppliers is a difficult task, especially for large suppliers who often fail to ship on time or directly deny accepting orders[3]. Often causes headaches for the material planner of Company A. Sometimes there may be situations where the supplier's contact person is irresponsible, using the shortage of raw materials as an excuse to ask the material planner of Company A to help them urge for raw materials. And for some cases where Company A can make suppliers claim compensation, it is also abandoned due to the complexity of the operation, the need to provide a lot of supporting materials, and the low success rate.

Secondly, Company A has not established a comprehensive supplier assessment index system. So often, material planners do not have a channel to provide feedback to the center when ordering materials, even if there are situations such as suppliers not delivering on time. The control of suppliers is crucial for Company A. From the perspective of the supply chain, only when all enterprises in the supply chain work together can the efficiency of the supply chain operation be improved; For Company A, controlling suppliers well can shorten delivery cycles, improve product quality, reduce costs, and enhance the company's adaptability and position in industry competition.

2. Optimization of Material Planning Issues in Company A

Common demand forecasting methods include time series analysis forecasting and causal analysis forecasting. Time series analysis and prediction methods can be further divided into moving average method, weighted moving average method, exponential smoothing method, seasonal trend prediction method, etc[4].

Due to the fact that the forecast data of Company A changes over time and shows a certain trend of change, time series analysis method is selected; Due to the fact that only one quarter of forecast data for Company A is currently available, seasonal trend forecasting method is not suitable.

Therefore, weighted moving average method and exponential smoothing method were used to obtain new forecast data, calculate the relative error value, and select the method with the smallest error.

2.1 Weighted Moving Average

The weighted moving average method adds different weights for each period on the basis of the simple moving average method to predict the demand quantity for the following periods. Set the weight of the 3-period moving average to 1:2:3.

The weighted moving average method was used to predict the forecast data for Company A's ZX483 project, and the results in the table below were obtained. Then, the average error of the company's actual initial forecast and the average error using the weighted moving average method were calculated.

Table 1. Calculation Results of Weighted Moving Average Method

Date	Initial Forecast	Weighted Moving Average Method	Actual Delivery	Initial Forecast Error	Weighted Moving Average Error
12-Oct	2985	2985	4335	31.14%	31.14%
19-Oct	4530	4530	5535	18.16%	18.16%
26-Oct	4500	4500	2912	54.53%	54.53%
2-Nov	4470	3609	4504	0.75%	19.87%
9-Nov	4455	3585	5010	11.08%	28.44%
16-Nov	4425	3568.5	5055	12.46%	29.41%
23-Nov	4155	3549	5340	22.19%	33.54%
30-Nov	4035	3405	5925	31.90%	42.53%
7-Dec	4110	3264	5130	19.88%	36.37%
14-Dec	3495	3265.5	5102	31.50%	36.00%
21-Dec	4125	2980.5	3075	34.15%	3.07%
28-Dec	1785	3111	3180	43.87%	2.17%
Average Error	-	-	-	25.97%	27.94%

2.2 Exponential Smoothing Method

Table 2. Calculation of Error Value by One-time Exponential Smoothing Method

Date	Initial Forecast Relative Error	Exponential Smoothing Relative Error						
	Initial Forecast	0.9	0.8	0.7	0.6	0.5	0.4	0.2
12-Oct								
19-Oct	18.16%	46.07%	46.07%	46.07%	46.07%	46.07%	46.07%	46.07%
26-Oct	54.53%	50.26%	44.95%	39.65%	34.34%	29.04%	23.73%	13.12%
2-Nov	0.75%	0.37%	1.33%	2.98%	5.31%	8.33%	12.04%	21.51%
9-Nov	11.08%	10.74%	10.88%	11.38%	12.42%	14.18%	16.86%	25.71%
16-Nov	12.46%	11.84%	11.83%	11.96%	12.40%	13.41%	15.31%	23.47%
23-Nov	22.19%	17.08%	17.02%	16.99%	17.11%	17.58%	18.75%	25.47%
30-Nov	31.90%	29.41%	28.94%	28.47%	28.04%	27.80%	28.01%	32.24%
7-Dec	19.88%	21.06%	20.66%	20.16%	19.56%	18.98%	18.65%	21.66%
14-Dec	31.50%	19.56%	19.60%	19.53%	19.31%	18.99%	18.70%	20.87%
21-Dec	34.15%	15.64%	17.61%	19.62%	21.74%	24.04%	26.40%	27.76%
28-Dec	43.87%	27.93%	26.52%	25.50%	24.92%	24.83%	25.22%	24.78%
Average Error	25.50%	22.72%	22.31%	22.03%	21.93%	22.11%	22.70%	25.70%

The exponential smoothing method is used to predict the future of a phenomenon by calculating the exponential smoothing value and combining it with a certain time series prediction model.

From the data of the ZX483 project of Company A, it can be seen that the actual delivery value of Company A tends to first decrease and then increase. Therefore, a trial calculation method was used for the smoothing coefficient a, with values of 0.7, 0.6, 0.5, 0.4, and 0.2 taken for testing, and the final results were compared to find a suitable smoothing coefficient for Company A. The final calculation result is as Table 2.

From the data in the table, it can be seen that Company A's own prediction error is 25.5%. When using the smoothing coefficient method for prediction, when the smoothing coefficients are set to 0.9, 0.8,0.7, 0.6, 0.5, 0.4, and 0.2, the prediction errors are 22.72%, 22.31%, 22.03%, 21.93%, 22.11%, 22.7%, and 25.7%, respectively. Therefore, it can be seen that when the smoothing coefficient is 0.6, the error is minimized.

Similarly, the quadratic exponential smoothing method was used to calculate the predicted values and their error values when the smoothing coefficients were 0.9, 0.8, 0.7, 0.6, and 0.5, respectively.

Table 3. Error results of quadratic exponential smoothing method

Date	Initial Forecast Relative Error	Exponential Smoothing Relative Error				
	Initial Forecast	0.9	0.8	0.7	0.6	0.5
Average Error	25.50%	16.38%	18.68%	21.47%	24.96%	29.40%

It was found that when the smoothing coefficient is 0.9, the error value is the smallest, with an error value of 16.38%. Therefore, a smoothing coefficient of 0.9 is more suitable for A company's demand forecasting.

3. Strengthen Supplier Control Measures

Suppliers refer to enterprises that can provide raw materials, equipment, tools, services, and other resources for enterprise production. Managing suppliers can help companies establish a stable and reliable supplier team, making production capacity more stable and quality more guaranteed. For Company A, managing suppliers has always been a challenge, especially with many car brands increasing their focus on manufacturing high-end models and specifying the use of raw materials from larger suppliers, making it even more difficult for Company A to manage suppliers.

For supplier management, it mainly focuses on four aspects: supplier selection, supplier assessment, supplier relationship management, and supplier quality management. In terms of supplier selection, we are unable to choose the materials specified by the customer. In terms of supplier assessment, Company A needs to develop corresponding supplier assessment indicators and apply these indicators to assess the comprehensive capabilities of suppliers. Supplier assessment indicators can be divided into quality indicators, supply indicators, economic indicators, and support, cooperation, and service indicators [5]. These four indicators can comprehensively and objectively evaluate the capabilities of suppliers in various aspects, which is conducive to enterprises discovering unqualified suppliers and suppliers with hidden dangers as soon as possible, ensuring that enterprises can meet customer requirements in product quality and timely delivery, and making the operation of the entire supply chain more efficient.

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