Raw Materials Purchasing Strategy Model for Complex Products Based on Time Series

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Abstract. A rolling purchasing strategy based on time series is proposed for the purchase of raw materials in the manufacturing process of complex products. The core idea of this strategy is to implement rolling procurement under the conditions of normal processing. According to the future price fluctuation of raw materials, a multi-stage purchasing model is established to minimize the total cost, solve the optimal purchasing quantity in each stage and implement the optimal purchasing quantity in the current period; when the next raw material procurement sequence is reached, according to the new order demand of the enterprise, update the information of time series, raw material demand, future price and other aspects of the model to obtain a new multi-stage procurement model, and then solve the optimal procurement volume in the current period, and so on.

1. Introduction

Complex products are characterized by large size, complex structure, customization, long cycle, etc., which is designed and produced according to the order. Manufacturing enterprises generally break down complex products into different stages of tasks. In the production process, the demand for raw materials is different at different stages. When an enterprise produces multiple products at the same time, the cooperation between production scheduling and resource procurement is difficult to optimize based on experience. The supply of raw materials further leads to the difficulty in controlling the cost of the products. How to develop raw material purchasing strategy to reduce the production cost is the problem to be researched in this paper.

At present, the research on raw material procurement strategy mainly considers the direct cost of purchase price fluctuation and the indirect cost of material inventory. Mahapatra [1] developed a model to determine the optimal pattern of procurement from the two arrangements for specified price, risk aversion and contract duration parameters. Hu [2] develop the joint procurement planning and pricing procedure to maximize the newsvendor's expected profit, and further develop a reality-adaptable solution algorithm to simplify the procedure, which quickly decreases the computational complexity when there exist multiple alternative suppliers and the procurement planning period is long. Calfa [3] propose three quantity-based purchase contract models: discount after a certain purchased amount, bulk discount, and fixed duration contracts. Li [4] develops a game-theoretic decision-making model of
production and procurement with commitment-option contracts in a decentralized supply chain. Chen [5] study the optimal procurement and operation of an oil refinery, and build a multiperiod inventory problem where each period involves an operation problem such as separation or blending. Li [6] develop a two-stage model and derive the optimal procurement policy for the firm. Nie [7] establish that the relative performances of the three heuristic strategies depend critically on the holding cost of raw material inventory and the competitive environment, and identify conditions. Goel [8] characterize the optimal financial hedging and procurement policies as a function of the term structure of the commodity prices, the correlation between the input and output prices, and the firm's operating characteristics.

Chen [9] proposed a purchasing strategy based on raw materials inventory, the model under raw materials price fluctuations for make to order enterprises with the goal of total costs minimal includes decision variables and the constraint. Lee [10] proposed a bi-level inventory replenishment strategy using clustering genetic algorithm, the computational results show that the net profit of the vendor and buyer under the bi-level strategy is higher than that under the integrated replenishment policy. Wang [11] introduce a supply chain methodology into humanitarian operations management by pre-purchasing relief supplies. Riza [12] established economic order quantity model to determine the optimal inventory level. Ateş [13] demonstrate that a strategy-structure misfit negatively impacts purchasing performance in both cost and innovation strategies.

2. Model Formulation

2.1. Purchasing strategy

The purchase cost of materials in manufacturing industry accounts for 60-80% of sales, such as steel for heavy equipment manufacturers, or copper for wire manufacturers. The price of raw materials \( P_{tj} \) changes in real time. Especially for steel, copper, crude oil, cotton and other commodities, due to various factors, such as international political situation, natural disasters, currency exchange rate, the relationship between supply and demand of raw materials, and market prices often fluctuate violently. The fluctuation of raw material price affects the stability of enterprise profit, which is related to the normal operation of the enterprise. Therefore, many enterprises to adopting appropriate strategies to control the cost of procurement and production, thus reducing the uncertainty of profits effectively.

In order to solve the raw material procurement problem, this paper proposes a rolling procurement strategy. Taking the processing time node of the manufacturing process as the purchasing time point, according to the current price and the future forecast price of raw materials, combined with the demand of the process, the minimum comprehensive cost model of raw material purchasing is established. In this model, the future price of raw materials can be predicted by time series method and autoregressive method. The forecast price has a certain deviation from the actual market price as shown in the following figure 1, which reflects that the short-term forecast deviation is small and the long-term forecast deviation is large. Therefore, when using the procurement model to determine the raw material purchasing quantity of each process, the purchasing near the current time point can implement the current purchasing; And then it comes to the next process, the new order of the enterprise will bring new demand for raw materials, therefore, it is necessary to use the procurement model again to update the parameters. The new purchasing volume is obtained use the model again, and current purchasing is implemented at the current time point; In the future processing, each process is optimized purchasing in accordance with the previous method, and then proceeds on a rolling basis, as shown in figure 2.

![Figure 1. Deviation between forecast price and actual price of raw material.](image_url)
2.2. Model description
Manufacturing of complex products is usually customized. There are great differences in processing route and manufacturing cycle of products with different orders. Specifically, the demand for materials is different in different manufacturing stages. Therefore, it is necessary to purchase a proper quantity of materials at appropriate time nodes to achieve the optimization of purchase order cost. By referring to the research of procurement cost optimization under unknown procurement time node, this paper proposes an optimization method of material procurement cost based on time series. That is to initialize the material procurement time node set based on the set of starting time points of each production process of complex products. The specific steps are as follows:

Assuming that the enterprise receives the order and decomposes the corresponding material details, manufacturing plan, outsourcing plan and so on. Finally, we can get the detailed list of material purchasing, production process and Gantt chart of time node arrangement.

(1) Setting up the set of start and end time points of each process in the whole manufacturing process of complex products;

(2) Choosing the earliest start time and the latest end time of the production process, and establishing the time coordinate axis with the span of the time d as the length and the day as the unit;

(3) Mapping the start time points of each process according to the date represented by the time coordinate axis calibration to obtain the set of coordinate axis calibrations corresponding to the start time points of the product process, such as \{3,15,21,...\} This set is used as time series of material purchasing.

After the time series of material purchasing is determined, the quantity of all kinds of material purchasing needs to be optimized with the purchase order cost. In the manufacturing process of complex products, the advance purchase of materials often takes up a large amount of funds and corresponding inventory management fees; and the lag of procurement will cause the interruption of product production and the loss of order delivery delay. Therefore, considering the cost of capital occupation, inventory management and procurement delay, we optimize the material procurement strategy based on time series, and then make the following assumptions combined with the actual situation of the enterprise:

(1) The manufacturing process of complex products has strict sequence, and the processing of different process segments has successive constraints;

(2) Inventory capacity and purchasing fund are not the restrictions of material purchasing strategy.

(3) The limitation of material supply is considered only in the process of processing each working section.

(4) According to the procurement lead time of general enterprises, the default material procurement time point is the delivery date;

(5) Delivery of an order may be delayed, but the delay will be subject to a fine.
To facilitate the establishment of rolling purchasing cost model, the following variables are defined in Table 1.

| Parameter | Description |
|-----------|-------------|
| $p_{si}$  | Process $i$ start time |
| $p_{ei}$  | Process $i$ end time |
| $N_{ij}$  | The number of raw materials $j$ required for process $i$ |
| $B_{ij}$  | The number of raw materials $j$ purchased for process $i$ |
| $q_{ij}$  | Initial stock of raw material $j$ |
| $y_i$     | Is process $i$ purchased |
| $P_{tj}$  | The unit price of raw material $j$ at time $t$ |
| $f$       | One-time purchase cost |
| $Q_{ij}^s$| Inventory of raw material $j$ before the start of process $i$ |
| $Q_{ij}^e$| Inventory of raw material $j$ at the end of process $i$ |
| $c_j$     | Unit time inventory management fee for raw material $j$ |
| $Mc$      | Raw material $j$ procurement total cost |
| $Fc$      | Total cost of one-time purchase |
| $W_{ij}$  | Total cost of Raw Material $j$ Inventory |
| $C$       | Total Purchasing Cost |

### 2.3. Objective function

#### 2.3.1. Cost of raw materials

According to the production needs of enterprises, raw material $N_{ij}$ is usually purchased before the start of process $i$. The quantity of raw material is $B_{ij}$, and the price of raw material $P_{tj}$ fluctuates with the market. Assuming that the purchase time is the arrival time at $psi$ at the current time point, the cost of raw materials purchased under the current market price is as follows:

$$Mc = \sum_{i=1}^{n} B_{ij} P_{tj}$$  \hspace{1cm} (1)

For the continuous production of the enterprise, the raw materials should have sufficient inventory before each process, and the following constraints must be met:

$$\sum_{j=1}^{k} B_{ij} + q_{ij} \geq \sum_{j=1}^{k} N_{ij}, \quad i = 1, 2, \ldots, n$$  \hspace{1cm} (2)

#### 2.3.2. One-time purchase cost

Every time a company purchases raw materials, it has to pay a fixed fee. If a purchase occurs, then $y_i=1$, otherwise $y_i=0$. The total cost of one-time purchase of raw materials is as follows:

$$Fc = \sum_{j=1}^{n} y_{ij} f$$  \hspace{1cm} (3)

If the quantity $j$ of raw materials purchased in the current process is $B_{ij}=0$, then $y_i=1$; if $B_{ij} \neq 0$, then $y_i=1$. $B_{ij}$ and $y_i$ satisfy the following relationship:

$$B_{ij} (y_i - 1) = 0, \quad i = 1, 2, \ldots, n$$  \hspace{1cm} (4)

#### 2.3.3. Raw material inventory cost

As the price of raw materials fluctuates on the market, enterprises generally hoard raw materials at low prices, thus reducing the procurement cost of raw materials, but the hoarding of raw materials will lead to the increase of inventory costs, the processing of raw materials $j$ in the early and late stages of processing $i$ quantity can be expressed as:
\[ Q^p_i = \sum_{k=1}^{i} B_{ij} + q_j - \sum_{k=1}^{i-1} N_{ij}, i = 1, 2, \ldots, n \]  
\[ Q^c_i = \sum_{k=1}^{i} B_{ij} + q_j - \sum_{k=1}^{i-1} N_{ij}, i = 1, 2, \ldots, n \]  

Therefore, during the entire time period of process \( i \), the average stock of raw material \( j \) can be expressed as:
\[ \bar{Q}_j = \frac{(Q^p_i + Q^c_i)}{2} = \sum_{k=1}^{i} B_{ij} + q_j + 0.5N_{ij} - \sum_{k=1}^{i-1} N_{ij}, i = 1, 2, \ldots, n \]  

The total inventory cost of raw material \( j \) is as follows:
\[ W_c = \sum_{i=1}^{n} \left[ \sum_{k=1}^{i} B_{ij} + q_j + 0.5N_{ij} - \sum_{k=1}^{i-1} N_{ij} \right] c_j \]  

2.3.4. Overall optimization objective function. In this paper, the raw material cost, one-time purchase cost and raw material inventory cost are taken into consideration to carry out optimization modeling. The optimal procurement model at \( psi \) is built as follows:
\[
\begin{align*}
\min C &= (Mc + Fc + Wc) \\
&= \sum_{i=1}^{n} B_{ij} P_{ij} + \sum_{i=1}^{n} y_i f + \sum_{i=1}^{n} \left[ \sum_{k=1}^{i} B_{ij} + q_j + 0.5N_{ij} - \sum_{k=1}^{i-1} N_{ij} \right] c_j \\
\text{s.t.} \quad &\sum_{k=1}^{i} B_{ij} + q_j \geq \sum_{k=1}^{i} N_{ij}, i = 1, 2, \ldots, n \\
&\sum_{k=1}^{n} B_{ij} + q_j = \sum_{k=1}^{n} N_{ij} \\
&B_{ij}(y_i - 1) = 0, i = 1, 2, \ldots, n \\
&y_i \in \{0, 1\}, i = 1, 2, \ldots, n \\
&B_{ij} \geq 0, i = 1, 2, \ldots, n
\end{align*}
\]  

In the whole process, according to the time series of the process and the raw materials needed by the process, an optimization model for purchasing is established, such as Formula (9), Formula (10), which means that in order to ensure continuous production, the stock of raw materials must be larger than the demand of the current process, Formula (11), which means that the inventory cost of raw materials is the smallest. As far as possible, after the current process is completed, the corresponding stock of raw materials is 0; Formula (12) and Formula (13) indicate whether the current process is purchased, and the quantity of \( B_{ij} \neq 0, y_i = 1 \); Formula (14) indicates that the purchasing quantity of raw materials is non-negative. It can be seen that model (14) is a non-linear mixed integer programming problem, which can be solved by linprog function in matlab.

3. Illustrative example

This part takes the raw material procurement of a building materials and equipment manufacturing enterprise as the background to illustrate the potential application of the rolling procurement strategy proposed above.

A building material equipment manufacturing enterprise in Tangshan is an order-oriented equipment manufacturing enterprise. The products required by customers’ orders are customized large-scale, complex and high-tech manufacturing equipment. The consumption of raw materials in the production process is high and the production cycle is long. In order to produce this kind of product, the enterprise adopts the order method. Single production mode. In this mode of production, how to optimize the management of raw materials needed for production, that is, to ensure the normal production of raw materials by formulating good purchase strategies, while paying lower inventory costs, is a problem that
needs scientific decision-making. This paper takes the most used steel procurement as an example, and puts forward the following suggestions. The rolling purchasing strategy model of raw materials based on time series is validated.

### Table 2. First-level BOM list of rotary kiln.

| Drawing serial number | Parts       | Sub-component     | Processing technology | Material | Weight (kg) | Processing begins on day $i$ | Production time (days) |
|-----------------------|-------------|-------------------|-----------------------|----------|-------------|-----------------------------|------------------------|
| 1                     | Rotary kiln|                   |                       |          |             |                             |                        |
| 1.1                   | Kiln tail seal| Bearing         | Rivet welding - Machining - Assemble | Q235B    | 5358.3375  | 80                          | 45                     |
| 1.1.1                 |             | Sealing ring     |                       |          | 228.9487    | 5                           | 10                     |
| 1.1.2                 |             | Friction ring    |                       |          | 1252.2      | 10                          | 10                     |
| 1.1.3                 |             | Bracket          |                       |          | 445.3322    | 5                           | 5                      |
| 1.1.5                 |             | Recycling spoon  |                       |          | 2496        | 15                          | 15                     |
| 1.2                   | Rotary part |                   | Rivet welding - Machining - Assemble | Q235B    | 313852.8036 | 1                          | 180                   |
| 1.2.1                 |             | Guard plate      |                       |          | 5256        | 5                           | 5                      |
| 1.2.2                 |             | Cylinder 1       |                       |          | 21013.703   | 20                          |                        |
| 1.2.3                 |             | Cylinder 2       |                       |          | 43653.806   | 20                          |                        |
| 1.2.4                 |             | Cylinder 3       |                       |          | 24519.006   | 20                          |                        |
| 1.2.5                 |             | Cylinder 4       |                       |          | 42964.206   | 20                          |                        |
| 1.2.6                 |             | Cylinder 5       |                       |          | 28783.638   | 20                          |                        |
| 1.2.7                 |             | Cylinder 6       |                       |          | 44493.806   | 20                          |                        |
| 1.2.8                 |             | Baffle block     |                       |          | 2620.8      | 5                           |                        |
| 1.2.9                 |             | Wheel 1          |                       |          | 32045       | 15                          |                        |
| 1.2.10                |             | Wheel 2          |                       |          | 62686       | 20                          |                        |
| 1.2.11                |             | Retaining ring   |                       |          | 2214        | 5                           |                        |
| 1.2.12                |             | Air cooling set  |                       |          | 2560.8      | 5                           |                        |
| 1.2.13                |             | Fixed plate      |                       |          | 1060.0386   | 5                           |                        |
| 1.3                   | Transmission device |             | Rivet welding - Machining - Assemble | Q235B    | 42101.4495  | 90                          | 60                     |
| 1.3.1                 |             | Large ring gear  |                       |          | 26927.386   | 30                          |                        |
| 1.3.2                 |             | Small ring gear  |                       |          | 4547.2874   | 15                          |                        |
| 1.3.3                 |             | Base             |                       |          | 7991.808    | 10                          |                        |
| 1.3.4                 |             | Gear cover       |                       |          | 2634.9681   | 5                           |                        |
| 1.4                   | Feed support device |             | Rivet welding - Machining - Assemble | Q235B    | 47021.1941  | 1                           | 85                     |
| 1.4.1                 |             | Base             |                       |          | 9613.9078   | 20                          |                        |
| 1.4.2                 |             | Carriage group   |                       |          | 26522.696   | 30                          |                        |
| 1.4.3                 |             | Bearing group    |                       |          | 8795.3179   | 25                          |                        |
| 1.4.4                 |             | Mechanical baffle wheel |               |          | 2089.2724   | 10                          |                        |
| 1.5                   | Hydraulic gear block |             | Rivet welding - Machining - Assemble | Q235B    | 7576.3022   | 80                          | 40                     |
| 1.6                   | Intermediate support device |         | Rivet welding - Machining - Assemble | Q235B    | 43837.8482  | 1                           | 75                     |
| 1.6.1                 |             | Base             |                       |          | 7621.5304   | 15                          |                        |
| 1.6.2                 |             | Carriage group   |                       |          | 26522.696   | 30                          |                        |
| 1.6.3                 |             | Bearing group    |                       |          | 8795.3179   | 25                          |                        |
| 1.6.4                 |             | Baffle block     |                       |          | 898.3039    | 5                           |                        |
| 1.7                   | Discharge support device |         | Rivet welding - Machining - Assemble | Q235B    | 43837.8482  | 1                           | 75                     |
| 1.7.1                 |             | Base             |                       |          | 7621.5304   | 15                          |                        |
This paper chooses the most common rotary kiln (serial number: KI/ZAM/3) equipment in building materials equipment manufacturing enterprises. The BOM list of the first level of this equipment is as follows Table 2. There are 13 parts in it. The raw materials of these parts are mainly channel steel, H-beam steel, I-beam steel and steel plate, and the material is Q235B structural steel. According to the manufacturing and processing capacity of the enterprise, the processing of 13 parts is reasonably arranged to 4 production teams, and the processing of sub-parts is decomposed. See Gantt Fig. 3 for details. According to Gantt chart, the time series set {1, 5, 15, 20, 25, 45, 50, 65, 70, 75, 80, 85, 90, 95, 105, 110, 120, 125, 130, 135, 140, 145, 150, 155, 160, 165, 170, 175} of parts can be set up. The time series is the time node of arrival of purchasing, and the quantity of raw materials required for each time node is as follows: {30112.9686 21013.703 53045.392 26522.696 43635.806 42109.6418 8795.3179 42964.206 1796.6078 2089.2724 7805.259 29719.4946 26927.386 1252.24939.1382 2496 4547.2874 4193.8 34379.9706 8184.964 863.2 688 838.831 1137.4685 897.1974 688 838.831 1137.4685 897.1974 2214 3232}, as shown in Figure 4. According to the actual situation of the enterprise, the purchase time node is usually purchased from half a month to one month. The purchase time node is converted into half a month purchasing, and the purchasing quantity as follows is shown in Figure 5.
Under the current market price fluctuations, the price of structural steel from January 2010 to December 2017 was selected as a sample, and the time series model, linear regression model and the combined model of the two were used to price the steel. Make predictions. The specific process of time series modeling is to obtain the ARIMA (1,1,1) of the steel price after the outlier observation, the stationarity test, the pure randomness test and the seasonal analysis process, and then use the price prediction model to obtain The predicted price of steel is shown in Table 3.

| Month | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late | Early | Late |
|-------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|-------|------|
| Jan   | 3710  | 3980 | 3950  | 4380 | 4180  | 4060 | 4120  | 4250 | 4420  | 4260 | 4335  | 4580 |

According to the needs of the company, preparations for procurement began in January, and the procurement was based on the optimal procurement model. The amount of raw materials purchased is representative of the amount of raw materials purchased in a time series of 1-6 months. Representation of whether to purchase. According to formula 9, the optimal purchasing model for January is established.
min C = 4145x_1^E + 4135x_1^E + 3955x_2^E + 3955x_2^E + 3985x_3^E + 4115x_3^E +3875x_4^E + 3875x_4^E + 4015x_5^E + 4125x_5^E + 4135x_6^E + 4128x_6^E +5000(y_1^E + y_2^E + y_3^E + y_4^E + y_5^E + y_6^E) +200 (x_1^E + 5500 + 51127 + 0.5 - 51127) + (x_2^E + x_1^F + 5500 + 123204 + 0.5 - 174331) + (x_3^E + x_2^F + 5500 + 0 - 0.5 - 174331) + (x_4^E + x_3^F + x_1^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 50905 + 0.5 - 225236) + (x_5^E + x_4^F + x_3^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 44761 + 0.5 - 269997) + (x_6^E + x_5^F + x_4^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 309614 + 0.5 - 396111) + (x_1^E + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 28180 + 0.5 - 337791) + (x_2^E + x_1^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 47435 + 0.5 - 385226) + (x_3^E + x_1^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 4312 + 0.5 - 389538) + (x_4^E + x_1^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 577687 + 0.5 - 467225) + (x_5^E + x_1^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 2492 + 0.5 - 469717) + (x_6^E + x_1^F + x_2^F + x_3^F + x_4^F + x_5^F + x_6^F + 5500 + 6517 + 0.5 - 476234) ] \[ \begin{align*}
& x_1^E + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 51127, x_1^E + x_2^E + 5500 \geq 174331, x_1^E + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 174331, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 225236, x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 269997, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 309611, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 337791, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 358226, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 389538, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 467225, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 469717, \\
& x_1^E + x_1^F + x_2^E + x_3^E + x_4^E + x_5^E + x_6^E + 5500 \geq 476234, \\
& x_i^E (y_i^E - 1) = 0, x_1^E (y_1^E - 1) = 0, i = 1,2,3,4,5,6 \\
& y_1^E, y_2^E, y_3^E, \ldots, y_6^E, y_i^E \in (0,1) \\
& x_1^E, x_1^F, x_2^E, x_2^F, \ldots, x_6^E, x_6^F \geq 0
\end{align*}\]

It can be solved by special software Lingo.

According to the analysis results, the optimal purchasing strategy of the enterprise is: purchasing 144.331 tons of structural steel at the beginning of January, and the purchase amount is 0 at the end of January. At the beginning of February, according to the received new orders and the decomposed time nodes, the demand for time series was re-established, and combined with the forecast of the price trend of raw materials, the new procurement strategy model was used to solve the purchase volume in February.

4. Conclusion

This paper proposes a time-based rolling procurement strategy for the procurement of raw materials in complex products in the long-cycle manufacturing process. The core idea of this strategy is to implement rolling procurement under the conditions of normal processing, that is, to establish a multi-stage procurement model that minimizes the comprehensive cost based on the future price fluctuation of raw materials, to solve the optimal purchase quantity at each stage and to implement the most current period. Excellent purchase volume; when the next raw material procurement sequence is reached, according to the new order demand of the enterprise, the time series, raw material demand, future price and other

\[ x_1^E = 144331, x_1^F = 50905, x_2^E = 0, x_2^F = 44761, x_3^E = 39614, x_3^F = 28180, x_4^E = 47435, x_4^F = 4312, x_5^E = 77687, x_5^F = 9009, x_6^F = 0. \]
aspects of the model are updated to obtain a new multi-stage procurement model and solved. The optimal purchase volume for the current period will be rolled out accordingly.

In this paper, the complex product manufacturing process is serialized, and the optimal procurement strategy is implemented with the starting point of the process as the raw material purchasing point. Under the condition of uncertain raw material price, the model is updated at the next time to solve the optimal purchasing plan. And implement current purchases. This method can effectively achieve the optimal total cost, and can be flexibly adjusted dynamically if new orders arrive and the price of raw materials changes. The rolling procurement strategy of raw materials proposed in this paper has certain significance for the further development and improvement of raw material procurement methods for complex product manufacturers. However, the accuracy of demand procurement and price forecasting for various materials has not been studied in depth. The next step can be considered Two factors improve the procurement strategy of raw materials..

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