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# *Research on raw material ordering and Transportation based on programming model*

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***Abstract:*** In this paper, aiming at the planning problem of optimal cost in the process of raw material supply, by establishing a mathematical model based on genetic algorithm to study the optimal ordering scheme and transportation scheme of the actual supply chain planning demand[1], an optimal planning model based on genetic algorithm is proposed[2]. The regression coefficient, supply error rate, fluctuation acceptability and large order proportion are established, and the importance of supplier guarantee enterprise production is evaluated by formula method, and the most important 50 enterprises are solved and screened out. At the same time, the 0-1 programming model with the minimum number of suppliers as the objective function was established, and 127 suppliers were needed to supply at least.

## 1. Background

Supply chain management refers to the process of planning, coordinating and optimizing the whole supply system in order to optimize the operation of the supply chain, so as to make the supply chain start from procurement and satisfy customers with the least cost.

## 2. Modeling and solving of problem 1

### 2.1 Global master

This question aims at the quantitative analysis of the supply characteristics of the supplier and establishes the evaluation model. Evaluate the importance of suppliers to ensure production and rank them from highest to lowest.

### 2.2 Model Establishment

The title gives the data of 402 suppliers, which are respectively the order quantity (240 weeks) of the enterprise to the supplier, denoted as D, the category of raw materials supplied by the supplier, and the weekly supply quantity (240 weeks) of each supplier, denoted as G. The weekly supply quantity of the supplier is written as $x_i$, and the average is written as $\bar{x}$, the number of business orders per week is denoted as $y_i$, and the average is denoted as $\bar{y}$.

In addition to the original data, the following indicators are also constructed by using the above reference conditions:

Regression coefficient: SPSS is used to calculate the regression coefficient between the supply quantity of the supplier and the order quantity of the enterprise, and judge the degree of its absolute value close to 1. The closer it is to 1, the higher the supply credibility of the enterprise is[3]. The specific calculation formula of regression coefficient is as follows:

$$R=\frac{\sum(\hat{y}_i-\bar{y})^2}{\sum(\hat{x}_i-\bar{x})^2} \quad (1)$$

Rate of supply error $\alpha$ : The supply error rate α represents the error ratio between the supply quantity of the supplier and the order quantity ordered by the enterprise. The difference between the supply quantity and the order quantity is calculated and then depicted by dividing the order quantity. The smaller the supply error rate α, the more stable the supply of the supplier. When the order quantity D is not equal to 0, the specific calculation formula of supply error rate $\alpha_{week}$ is as follows:

$$\alpha_{week} = \frac{|G-D|}{D} \quad (2)$$

The total supply error rate α takes the 4 average values of the effective weeks, and the specific calculation formula is as follows:

$$\alpha = \frac{\sum \alpha_{week}}{240-num(G=D=0)} \quad (3)$$

Acceptability of fluctuations$\beta$: For production enterprises, they need to have a certain ability to bear risks. When the supplier's supply is unstable, if the quantity of supply changes within a proper range, the manufacturer can bear the pressure without too much impact on its own production. Therefore, as long as the supply error rate α is not 30%, it can be considered that the supply is relatively stable. The specific calculation formula is as follows:

$$\beta = \frac{num(\alpha \le 30\%)-num(D=G=0)}{240-num(D=G=0)} \quad (4)$$

Proportion of large orders$\delta$: For suppliers, the more large orders they supply, the more stable their supply channels will be. The specific calculation formula is as follows:

$$\delta = \frac{num(G \ge 500)}{240-num(G=D=0)} \quad (5)$$

## 2.3 Model Solution

In the overall quantization of suppliers, the orders of A, B and C are added up separately, and all evaluation quantities are calculated:

*Table 1: The evaluation quantity of three products*

| product classification | A | B | C |
|---|---|---|---|
| Supplier quantity | 146 | 134 | 122 |
| Regression coefficient $R$ | 0.593 | 0.895 | 0.738 |
| Rate of supply error $\alpha$ | 0.480 | 0.472 | 0.427 |
| Acceptability of fluctuations$\beta$ | 0.469 | 0.469 | 0.534 |
| Proportion of large orders$\delta$ | 0.087 | 0.075 | 0.084 |

It can always be seen that the supply error rate and volatility acceptability index of raw material C are the best, that is to say, the supplier of raw material C does the best job in ensuring the importance of enterprise production compared with A. Although the supplier of raw material B has excellent performance in regression coefficient, its performance in other aspects is unsatisfactory, and it does the worst in ensuring the importance of enterprise production. Therefore, in the subsequent selection process, suppliers of raw material A and C should be selected as far as possible.

According to the importance model of individual suppliers guaranteeing enterprise production, the 50 most important suppliers are finally obtained as follows:

*Table 2: The 50 most important companies*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | S275 | **9** | S108 | **17** | S308 | **25** | S346 | **33** | S244 | **41** | S211 | **49** | S139 |
| **2** | S229 | **10** | S194 | **18** | S365 | **26** | S367 | **34** | S080 | **42** | S003 | **50** | S379 |
| **3** | S329 | **11** | S151 | **19** | S284 | **27** | S055 | **35** | S180 | **43** | S078 | | |
| **4** | S340 | **12** | S131 | **20** | S031 | **28** | S395 | **36** | S348 | **44** | S126 | | |
| **5** | S361 | **13** | S356 | **21** | S364 | **29** | S218 | **37** | S189 | **45** | S037 | | |
| **6** | S268 | **14** | S352 | **22** | S040 | **30** | S362 | **38** | S005 | **46** | S351 | | |
| **7** | S306 | **15** | S247 | **23** | S143 | **31** | S388 | **39** | S270 | **47** | S366 | | |
| **8** | S282 | **16** | S330 | **24** | S294 | **32** | S397 | **40** | S273 | **48** | S123 | | |

## 3. Modeling and solving of problem 2

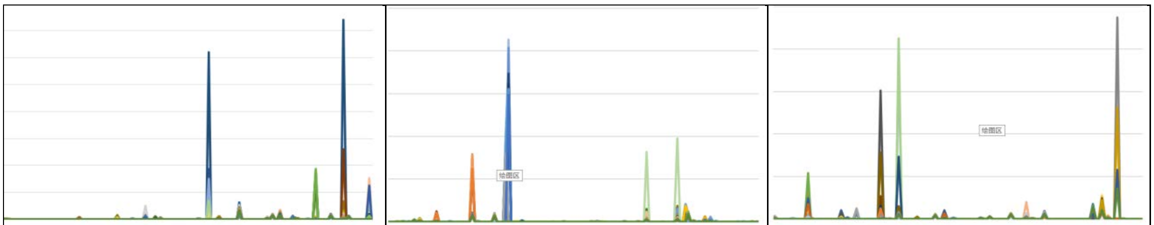
### 3.1 Constraint condition

Calculate the production capacity that can be provided by raw materials A, B and C respectively, and then add them up, requiring that the final value should be greater than the required capacity of 2.82*104 cubic meters. Special attention should be paid to the fact that for the first week, raw materials needed for the first and second weeks should be purchased in the first week, so the corresponding capacity of two weeks should be 5.64*104 cubic meters. The specific mathematical expression is:

$$98\% \times \left(\frac{r_A \cdot MAX_A}{0.6} + \frac{r_B \cdot MAX_B}{0.66} + \frac{r_C \cdot MAX_C}{0.72}\right) \geq \begin{pmatrix} 5.64 \times 10^4 & & & \\ & 2.82 \times 10^4 & & \\ & & \cdots & \\ & & & 2.82 \times 10^4 \end{pmatrix} \tag{6}$$

### 3.2 Assumption

The 402 suppliers were separated according to the supply type A, B and C, and were still ranked according to the serial number of the original supplier from the smallest to the largest in each supply type.



Picture of supplier of A | Picture of supplier of B | Picture of supplier of C

*Figure 1: Weekly supply line chart of suppliers*

Assume that the maximum quantity each supplier can supply is the maximum quantity the store has supplied during that time period in the past year. Take the fixed value as the upper limit of each supplier's supply for each month of the year. Through calculation, it is found that there are A total of 146 suppliers supplying raw material A, the weekly supply limit of 146 suppliers is set as $MAX_A$, 146 rows of the matrix respectively represent 146 suppliers, and 24 columns respectively represent the maximum value at this time point in each year, so as to obtain:

$$MAX_A = \begin{pmatrix} 2 & 0 & \cdots & 1 \\ 65 & 64 & \cdots & 84 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{pmatrix} \tag{7}$$

## 3.3 Objective function

The minimum number of suppliers is the explicit objective function of this programming model. May wish to use the above selection matrix $S_A$, you can add the 24 data of each column of each matrix, if the data is not equal to 0, it can indicate that the store was purchased during the supply process. Similarly, add $S_B$ and $S_C$ to the 0-1 matrix of variables. Objective function $t_1$ is expressed as:

$$min\ \ t_1 = num\left(\sum_{i=1}^{24}(r_A)_{ij} \neq 0\right) + num\left(\sum_{i=1}^{24}(r_B)_{ij} \neq 0\right) + num\left(\sum_{i=1}^{24}(r_C)_{ij} \neq 0\right) \tag{8}$$

## 3.4 Model Solution

According to the above planning model, the enterprise should select at least 127 suppliers to supply raw materials to meet the demand of production, and the selected suppliers are:

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **2** | **3** | 4 | **5** | 6 | **7** | 8 | 9 | **10** | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | **23** | 24 | **25** | 26 | 27 | **28** | 29 | **30** | **31** | 32 | 33 | 34 | 35 | 36 | **37** | 38 | 39 | **40** |
| 41 | **42** | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | **54** | **55** | 56 | 57 | 58 | 59 | 60 |
| 61 | 62 | 63 | 64 | 65 | **66** | 67 | 68 | **69** | 70 | 71 | 72 | 73 | **74** | **75** | **76** | **77** | 78 | 79 | **80** |
| 81 | 82 | 83 | 84 | 85 | **86** | 87 | **88** | **89** | **90** | 91 | **92** | 93 | 94 | 95 | 96 | 97 | **98** | 99 | 100 |
| 101 | 102 | 103 | **104** | 105 | 106 | 107 | **108** | 109 | **110** | 111 | 112 | **113** | **114** | **115** | 116 | **117** | 118 | 119 | 120 |
| **121** | 122 | **123** | 124 | 125 | **126** | 127 | 128 | **129** | 130 | **131** | 132 | 133 | 134 | 135 | 136 | 137 | **138** | **139** | **140** |
| **141** | 142 | **143** | 144 | 145 | **146** | 147 | 148 | 149 | **150** | **151** | **152** | **153** | **154** | 155 | 156 | **157** | 158 | 159 | 160 |
| 161 | 162 | **163** | 164 | 165 | 166 | 167 | 168 | **169** | 170 | 171 | **172** | 173 | **174** | **175** | 176 | 177 | 178 | 179 | **180** |
| 181 | 182 | 183 | 184 | 185 | **186** | 187 | 188 | **189** | 190 | **191** | 192 | 193 | **194** | 195 | 196 | **197** | 198 | **199** | 200 |
| **201** | **202** | 203 | 204 | 205 | 206 | 207 | **208** | 209 | **210** | 211 | 212 | **213** | **214** | 215 | **216** | 217 | **218** | 219 | 220 |
| **221** | 222 | 223 | **224** | 225 | **226** | 227 | **228** | **229** | 230 | 231 | **232** | **233** | 234 | 235 | 236 | 237 | 238 | **239** | 240 |
| 241 | 242 | 243 | **244** | **245** | **246** | **247** | 248 | 249 | 250 | 251 | 252 | 253 | **254** | 255 | **256** | 257 | **258** | 259 | 260 |
| 261 | 262 | **263** | 264 | 265 | **266** | **267** | **268** | 269 | **270** | 271 | 272 | **273** | 274 | **275** | 276 | 277 | 278 | 279 | **280** |
| 281 | **282** | 283 | 284 | 285 | 286 | 287 | 288 | 289 | 290 | **291** | **292** | 293 | **294** | 295 | 296 | 297 | 298 | 299 | **300** |
| 301 | 302 | 303 | 304 | 305 | **306** | **307** | **308** | 309 | **310** | 311 | 312 | **313** | **314** | 315 | 316 | 317 | 318 | 319 | 320 |
| 321 | 322 | 323 | **324** | 325 | 326 | 327 | 328 | **329** | **330** | **331** | 332 | **333** | 334 | 335 | 336 | 337 | **338** | 339 | **340** |
| 341 | 342 | 343 | 344 | 345 | **346** | 347 | **348** | 349 | 350 | 351 | **352** | 353 | 354 | 355 | **356** | 357 | 358 | 359 | **360** |
| **361** | **362** | 363 | **364** | **365** | 366 | **367** | 368 | **369** | 370 | 371 | 372 | 373 | **374** | 375 | 376 | 377 | 378 | 379 | 380 |
| 381 | 382 | **383** | 384 | 385 | 386 | 387 | 388 | 389 | 390 | 391 | 392 | 393 | 394 | **395** | 396 | 397 | 398 | 399 | 400 |

*Figure 2: Selected suppliers*

## 4. Evaluation of Model

1. This paper adopts mainly planning model to analyze production planning scheme layer by layer, and uses 0-1 variable matrix to facilitate calculation.

2. This paper puts theoretical values into the model for many times, and tries to simulate possible situations in real life to make the conclusion more rigorous and scientific.

3. The convergence rate of ordinary mathematical programming model is slow, and it may

converge to the local optimal solution, and the global optimal solution cannot be obtained.

## References

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