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Research Article

Food Production Enterprise Production Planning and Scheduling

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Abstract: As we all known, Production planning and scheduling is one of the important parts of food production production and management. Thus, the decision capacity of production planning will greatly and directly affect the economic benefits of companies and the development of operations. This study will describe the production scheduling problem of food production companies, by summarizing and review the previous studies, we specially introduce the use of programming optimization in food production production planning and scheduling and then analyze the instance son, build model using mathematics methods and finally solve the problem with software.

Keywords: Food production enterprise, optimization, planning and scheduling, production scheduling, programming

INTRODUCTION

The relationship between humans and the food production is very close, spreading to all aspects of life. In modern life, we can't live without food production products anytime and anywhere, from the material life such as clothing, food, shelter to the spiritual life for example culture, arts and entertainment. Their production and use, even on behalf of a certain historical stage of human civilization.

Production scheduling problem of food production researches has attracted the attention of many scholars. Kiran and Smith (1984) summarized the research status in a dynamic environment based Job shop scheduling a simulation model of the pure (Montazeri and Van Wassehove, 1990). Rule bases scheduling method including the 20 common rules and for an actual FMS, analyzes the average waiting time of these rules, such as operations on the system performance, the machine the average utilization, the total processing time of the job impact. Wu *et al*. (2003) with a flexible PCB (printed circuit board) to install the system as an example, the scheduling method is proposed based on KBS knowledge (Knowledge one Based Scheduling).

Mathematical programming is one of the main methods of research and production scheduling. Voudouris and Grossman (1996) for Zero Wait for the next (ZW) operation the batch process scheduling problems have been studied and established a complex MILP model and proposed several simplified method for solving. Pinto and Grossman (1996) Presents a continuous time MILP model focuses on short-term scheduling problem of parallel devices. This model uses a pre-sorting (pre-ordering) strategy, with some simple arithmetic processing of pre-determined sequence of different batches, thereby reducing the number of binary variables in the model, accelerate the solving model. This study will use the mathematical programming method for a food production plant for production scheduling optimization.

METHODOLOGY

Example description: ZE daily food production plant is a professional production and sales of cleaning products business in southern China, the main products include special effects floor cleaning liquid, efficient dishwashing detergent, ZE hand washing gel, bleach, efficient toilet cleaner, air freshener. In addition to these six products sold outside alone, companies also packaged these products into a package promotions to market, including: a toilet kit numbered as one (two boxes effects floor cleaning liquid, two ZE hand washing gel, three air fresheners, two efficient cleaning toilet agent and an emulsifier), bedroom suit numbered as two (two effects floor cleaning liquid, an air freshener and a decoration), hall suit numbered as three (four effects floor cleaning liquid, an air freshener and a piece ashtray) and kitchen kits numbered as four (three effects floor cleaning liquid, two ZE hand washing gel, three efficient dishwashing detergent and one emulsifier). Among them, emulsifiers, ornaments and ashtrays are company's outsourcing products, as sales of packaged kits donated gifts.

With the development of enterprises, ZE food production plant through acquisitions opened two plants in eastern China and central China, mainly serving the local market. Because of the ability of different regions

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Table 1: Unit variable costs and benefits of different plant's products (unit: RMB)

	The factory in south China		The factory in east China		The factory in central China	
Product name	Unit cost	Unit selling price	Unit cost	Unit selling price	Unit cost	Unit selling price
Special effects floor cleaning solution	12	22	13	22	13	24
Efficient dishwashing detergent	12	25	13	24	13	24
ZE wash hands dew	9	18	9	20	7	18
Bleaching powder	9	15	10	16	11	16
Efficient toilet bowl cleaner	15	27	17	28	18	30
Air freshener	8	18	10	20	10	20
Toilet kit 1	115	140	116	140	115	118
Bedroom suite 2	40	50	42	55	45	55
Hall suite 3	56	70	55	75	55	75
Kitchen suite 4	90	110	90	110	92	115

Table 2: Labor consumption and maximum production capacity of different plant's products

	The factory in south China		The factory in east China		The factory in central China	
Product name	Unit cost	Unit selling price	Unit cost	Unit selling price	Unit cost	Unit selling price
Special effects floor cleaning solution	0.10	0.05	0.12	0.05	0.10	0.04
Efficient dishwashing detergent	0.10	0.05	0.10	0.04	0.12	0.05
ZE wash hands dew	0.12	0.08	0.15	0.08	0.12	0.09
Bleaching powder	0.15	0.10	0.20	0.10	0.15	0.12
Efficient toilet bowl cleaner	0.15	0.10	0.12	0.12	0.13	0.10
Air freshener	0.12	0.10	0.11	0.12	0.11	0.10
Labor hours	9500	6000	11000	6400	9800	6500

Table 3: Hours and productivity suite packaging ability of different plants

	The factory in south China	The factory in east China	The factory in central China
Packing unit working hours	0.25	0.20	0.25
The number of hours available	1180	1000	1330

Table 4: Predict future market demand for the next 2 months

Product	The factory in south China	The factory in east China	The factory in central China
Special effects floor cleaning solution	(10000, 20000)	(11000, 20000)	(10000, 20000)
Efficient dishwashing detergent	(12000, 22000)	(15000, 22000)	(12000, 20000)
ZE wash hands dew	(5000, 11000)	(4500, 8000)	(4500, 11000)
Bleaching powder	(10000, 15000)	(12000, 18000)	(10000, 17000)
Efficient toilet bowl cleaner	(4000, 8000)	(3000, 6000)	(4500, 7000)
Air freshener	(1000, 5000)	(1000, 6000)	(1100, 5000)
Toilet kit 1	(2000, 5000)	(2000, 5000)	(2200, 5500)
Bedroom suite 2	(200, 1000)	(500, 1500)	(300, 800)
Hall suite 3	(500, 2000)	(300, 1500)	(500, 1500)
Kitchen suite 4	(2000, 8000)	(2000, 10000)	(1000, 9000)

of the consumer, the purchase price of raw materials and employee wages are not the same, XD food production plant producing these products, the cost and the market price is not the same in different regions. There are large differences in different parts of the level of demand for these products as well.

The following gives the unit costs of different plants to produce these products (Table 1) and market retail price data (due to the production and sale of kits requiring additional packaging costs and procurement costs for emulsifiers, decorations and ashtrays, kit costs slightly higher than its total cost of each single piece).

Similarly, different plant machinery and equipment, as well as the level of quality of the staff, resulting in the production of the same product consumption per unit of labor is not the same, the time in which the package also includes the factory transmission time. Specific data are as follows (unit: hour).

In addition, the factory packaging kit also need to spend additional labor and different packaging kit consumed artificial plants is not the same (different kits consumption is basically the same).

According to data provided by the factory sales department, the next two months will be entered into the peak of this year's demand, the demand for different products in different regions roughly estimated as follows (Table 2 to 4).

It is known that the cost of production (Table 1 unit costs) will rise by 10% each month. For this reason and to consider the plant's production capacity, the plant production department will use inventory ways to resist inflation, which in the first month produce more products that will leave it to the first two months sales. However, such a production and inventory strategies will bring the plant's inventory costs by 5% (5% of production costs per unit of product). Also, due to the high cost of transportation products, factory will not use regional supplier of ways to meet the demand, that is, different regions of products for the needs of the region's markets.

This study will be based on the actual situation currently facing, arranging the plant's production schedule for the past two months (2 months later, the plant is no longer left in finished goods inventory of these products) to obtain the maximum profit.

MATHEMATICAL MODELING

Symbol:

$X_{i,j,m}$ = "i" the name of products, "j" the production area, "m" the right month

$p_{i,j}$ = Prices in the products "i" in region "j"

$c_{i,j,m}$ = The unit cost of product "i" in the region "j" in the month "m"

$I_{i,j}$ = The "i" product after the first month as the stock number in the region "j"

$t_{i,j}$ = The district production time of the product "i" in the region "j"

T_j = The total regional production hours in the region "j"

$t^0_{i,j}$ = The total work time of packaging products "i" in the region "j"

T^0_j = The total work time of packaging products in the region "j"

$t^l_{i,j}$ = The total packaging time of suit "i" (i>6) time in the region "j"

T^l_j = The total work time of packaging suit in the region "j"

$DB_{i,j}$ = The demand for the lower region of the "i" product in the region "j"

$UB_{i,j}$ = The needs of the upper region of the "i" product in the region "j"

Target equation:

$$Max\sum_{m=1}^{2}\sum_{j=1}^{3}\sum_{i=1}^{10}X_{i,j,m}(p_{i,j}-c_{i,j,m})-\sum_{j=1}^{3}\sum_{i=1}^{10}I_{i,j}0.05c_{i,j,1}$$

wherein, $c_{i,j,2}$ is equal to $c_{i,j,1}$ (1+10%).

Constraints:

Production hours: $\sum_{i=1}^{10}X_{i,j,m}t_{i,j}\le T_j$

Packaging hours: $\sum_{i=1}^{10}X_{i,j,m}t^0_{i,j}\le T^0_j$

Kit packaging hours: $\sum_{i=7}^{10}X_{i,j,m}t^1_j\le T^1_j$

Market forecast: $DB_{i,j}\le X_{i,j,m}\le UB_{i,j}$

where, i = 1, 2, ..., 10 j = 1, 2, 3 m = 1, 2.

```
set products;
set areas;
set months ordered;
param cost{products,areas,months};
param price{products,areas};
param produce_time{products,areas};
param pack_time{products,areas};
param produce_time_avail{areas};
param pack_time_avail{areas};
param unit_work_time{products,areas};
param total_work_time{areas};
param marketdownbound{products,areas};
param marketupbound{products,areas};
var make{products,areas,months} integer >=0;
var inventory{products,areas}>=0;
maximize totalprofit:sum{p in products,a in areas,m in months}make[p,a,m]*(price[p,a]-cost[p,a,m])
-sum{p in products,a in areas}inventory[p,a]*cost[p,a,first(months)]*0.05;# maybe we can not use 5%
subject to producetimelimit{a in areas,m in months}:
sum{ p in products}make[p,a,m]*produce_time[p,a]<=produce_time_avail[a];
subject to packtimelimit{a in areas,m in months}:
sum{ p in products}make[p,a,m]*pack_time[p,a]<=pack_time_avail[a];
subject to worktimelimit{a in areas,m in months}:
sum{ p in products}make[p,a,m]*unit_work_time[p,a]<=total_work_time[a];
subject to marketmonthM1{p in products,a in areas}:
marketdownbound[p,a] <= make[p,a,first(months)]-inventory[p,a] <= marketupbound[p,a];
subject to marketmonthM2{p in products,a in areas}:
marketdownbound[p,a] <= make[p,a,last(months)]+inventory[p,a] <= marketupbound[p,a];
```

Fig. 1: AMPL programming template file

```
CPLEX 12.6.0.1: optimal integer solution within mipgap or absmipgap; objective 3032382.15
25 MIP simplex iterations
0 branch-and-bound nodes
absmipgap = 6.89577, relmipgap = 2.27404e-06
make [*,*,monthM1]
:          areaA   areaB   areaC    :=
productA   10000   11000   20001
productB   14760   16430   12000
productC    5000    4500    4500
productD   10000   12000   10000
productE    4000    3000    4553
productF    1000    1000    1100
productG    2000    2000    2200
productH     200     500     600
productI     500     300     500
productJ    2000    2000    1000

 [*,*,monthM2]
:          areaA   areaB   areaC    :=
productA   10000   11000   19999
productB   14760   16430   12000
productC    5000    4500    6166
productD   10000   12000   10000
productE    4000    3000    4447
productF    1000    1000    1100
productG    2000    2000    2200
productH     200     500       0
productI     500     300     500
productJ    2000    2000    1000
```

Fig. 2: AMPL programming calculations

Table 5: South China factory production quantity

	The factory in east China				
Product	First month sales	First month inve'y	First month prod'n	Second month prod'n	Second month total sales
Special effects floor cleaning solution	11000	0	11000	11000	11000
Efficient dishwashing detergent	16430	0	16430	16430	16430
ZE wash hands dew	4500	0	4500	4500	4500
Bleaching powder	12000	0	12000	12000	12000
Efficient toilet bowl cleaner	3000	0	3000	3000	3000
Air freshener	1000	0	1000	1000	1000
Toilet kit 1	2000	0	2000	2000	2000
Bedroom suite 2	500	0	500	500	500
Hall suite 3	300	0	300	300	300
Kitchen suite 4	2000	0	2000	2000	2000

Table 6: Total factory cost and profit

Costs	6330720
Income	9363830
Gross profit	3033110

Problem solving: Because of the complexity of the model, AMPL software is used to solve the model. The results are as follows (Fig. 1 and 2, Table 5 and 6).

CONCLUSION

Production planning and scheduling is an important process of the production process in business decision-making, the reasonable making or not directly affect the Economic benefits of companies, we take the food production industry as the main line of this study, using the linear programming theory describes the impact of linear programming function elements and each variable's change in analysis, which is made use of in the Examples.

Food production industry is one of the most successful areas in using applications of programming, we can see that programming optimization program has matured, it has created enormous economic benefits for the food production industry in the application of the world, China's food production industry should speed up plans to optimize the application itself speed, further narrowing the gap with foreign advanced application level. Programming technologies in the food production industry are getting more and more used program. The system to optimize with other applications are also being built to connect seamlessly from the application of these production operations management staff, laying with the plan to optimize the use of work-related foundation, which is to catch or exceed one of shortcuts in foreign advanced levels.

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