Available online at www.elixirpublishers.com (Elixir International Journal)

Production Management

Elixir Prod. Mgmt. 86 (2015) 34765-34769

ISSN: 2229-712X

Introduce a model in order to production balance with the aim of improving for total expected cost and determination the best path to transport raw materials by using of Topsis method

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ARTICLE INFO

Article history:

Received: 19 January 2013;
Received in revised form:
22 August 2015;
Accepted: 29 August 2015;

Keywords

Linear programming,
Total expected cost,
Production,
Balance,
Classifying,
Transportation.

ABSTRACT

This article Based on case study in Sanaye Felezi Iran Co. in this research, introduce a model in order to the production balance with the aim of improving for total expected cost. In the first step of research, introduce a linear programming model to determination the number of production in any production department. In the second step, by using the Hungarian allocation technique, the operator was allocated to any work stations. In the third step, introduce a Transportation programming model with the aim of improving for raw materials cost to any production departments. In the fourth step, with the use of 'technique for order preference by similarity to ideal solution' (TOPSIS), to determination the best transportation route, classifying material transportation routes from warehouses to assembly shop.

Introduction

These days, daily increasing of competitive conditions in markets, customer services and essential progress in information technology and communication industries caused to satisfying the customers in appropriate quality of product, low price in comparison to other competitive and on time delivery of product, has the essential role in remaining of organizations at markets and getting the market's proportion. For this reason the concept of production balance is posed during these two decades.

Production balancing problem the issues that in recent decades, extensive studies have been done on. Production balancing problem is to ensure equal operating time according to production rate required. Among the issues that production managers are always facing, stoppages occurred in assembly lines. Among the main reasons for stoppages, not balanced production lines and not correct planning in supply of raw materials. Balances the production system reason to increasing discipline in production process and clarify the roles of staffs and timely supply of raw materials and thus increases the efficient of the production system (Javid, 2004).

Balancing production model presented in this study, in composed of four main steps that reason to production balance and transportation balance with the aim of improving for total expected cost.

Literature Review

Production

Production is the act of creating output, a good or service which has value and contributes to the utility of individuals. The act may or may not include factors of production other than labor. Any effort directed toward the realization of a desired product or service is a "productive" effort and the performance of such act is production. The relation between the amount of inputs used in production and the resulting amount of output is called the production function. (Javid, 2004).

Production Balancing

Balancing problem is to ensure equal operating time according to production rate required. Production balancing problem the issues that in recent decades, extensive studies have been done on. (Javid, 2004).

Production management

The production management team (consisting of a production manager and any number of assistants) is responsible for realizing the visions of the producer and the director or choreographer within constraints of technical possibility (Javid, 2004).

Planning

Planning is the process of thinking about and organizing the activities required to achieve a desired goal. Planning involves the creation and maintenance of a plan. As such, planning is a fundamental property of intelligent behavior. This thought process is essential to the creation and refinement of a plan, or integration of it with other plans; that is, it combines forecasting of developments with the preparation of scenarios of how to react to them. (Javid, 2004).

Research Methodology

Case Study

This article Based on case study in Sanaye Felezi Iran Co. in this research, introduce a model in order to the production balance with the aim of improving for total expected cost.

Introduce a linear programming model to determination the number of production in any production department

At this stage of the research aimed at improving the total expected cost of production for each of products per hour. The

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decision variables are number of products that should be produced per hour. This model has five constraints shall be produced 200 products. Second to fifth constraints represent the minimum and maximum production capacity.

Figure 1: Research Practical Model

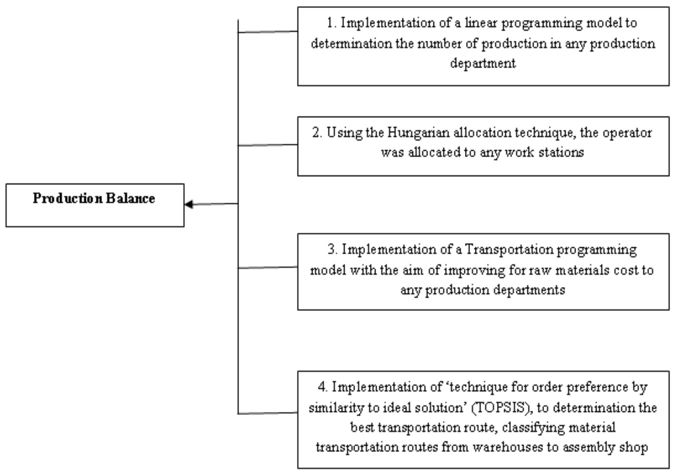

Table 1: Cost of Production any product

Product	Cost (Taman per hour)
1	5100
2	4700
3	4900
4	4800
5	6700
6	4200
7	6100

Linear programming model in this step of research is:

$$Min\ Z = 5100X_1 + 4700X_2 + 4900X_3 + 4800X_4 + 6700X_5 + 4200X_6 + 6100X_7$$

$$s.t:$$

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 = 6$$

$$0.6 \le X_1 \le 1$$

$$0.6 \le X_2 \le 1$$

$$0.5 \le X_3 \le 1$$

$$0.5 \le X_4 \le 1$$

$$0.5 \le X_5 \le 1.5$$

$$0.9 \le X_6 \le 1.5$$

$$0.36 \le X_7 \le 0.7$$

$$X_i \ge 0\ ;\ i = 1,2,....,7$$

Using the Hungarian allocation technique, the operator was allocated to any work stations

At this stage of the research aimed at optimum allocation of production operators to each work station based on the measured time (min) for production operations in a production cycle. (Operators are multi – purpose).

Table 2: The measured time (min) for production operations in each work station

Work Station / Operators Group	1	2	3	4	5
Group 1	107.311	127.9	66.657	66.39	171.94
Group 2	106.59	127.86	66.274	66.791	171.853
Group 3	105.88	129.21	66.429	66.952	172.1
Group 4	106.37	128.42	67.1	66.546	171.832
Group 5	106.23	128.73	66.681	66.588	171.938

Introduce a transportation programming model with the aim of improving for raw materials cost to any production departments

At this stage of the research aimed at improving the total expected cost of transporting raw materials from 3 warehouses to each production department. (This assembly saloon has 4 departments)

Table 3: The measured time (min) for production operations in each work station

4	3	2	1	Work Station / Warehouse
13	22	2	12	1
22	11	9	14	2
20	18	16	2	3

(Costs in 100× Taman per hour)

According to the existing lift trucks (4 lift trucks exist) in factory, is the average of ability amount to carry pallets per hour from warehouses to the production departments and also is the average number of pallets needed:

Table 4: Average of ability amount to carry pallets per hour

Need (Palette)	Work Station
5	1
15	2
15	3
10	4

Table 5: Average of ability amount to carries

The average of ability amount to carry pallets per hour	Warehouse
15	1
25	2
5	3

With the use of 'technique for order preference by similarity to ideal solution' (TOPSIS), to determination the best transportation route, classifying material transportation routes from warehouses to assembly shop

At this stage of the research aimed at determination the best materials transportation route by any lift trucks from warehouses to production departments. For this purpose, three indexes: distance, transportation time and transportation cost are considered. Weights matrix is obtained by using entropy method.

Table 6: Initial table to selecting optimum transportation route by Topsis technique

The Average of Transportation Time (min)	Supply Quality Status	Distance (meter)	Index / Alternative
4	Very good	53	**Route: 1**
2.5	middle	76	**Route: 2**
3	good	43	**Route: 3**

At this stage of the research for Qualitative values into quantitative, bipolar scale space method has been used.

The steps of this section are:

a. Determination the decision making matrix

$$\begin{bmatrix} 53 & 9 & 4 \\ 76 & 5 & 2.5 \\ 43 & 7 & 3 \end{bmatrix} = A$$

b. Determination the weighted matrix by using of entropy technique

b.1. Determination the P matrix:

$$P = \begin{bmatrix} 0.31 & 0.43 & 0.42 \\ 0.44 & 0.24 & 0.26 \\ 0.25 & 0.33 & 0.31 \end{bmatrix}$$

b.2. Determination the Ej matrix :

Ej = [0.971 0.971 0.974]

b.3. Determination the Éj matrix :

Éj = 1- Ej = [0.029 0.029 0.026]

b.4. Determination the Éj matrix:

Wj = Éj ÷ Σ Éj

Wj = [0.345 0.345 0.31]

c. Determination the D matrix

$$D = [d_{ij}]_{m \times n} , \quad d_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}}$$

$$D = \begin{bmatrix} 0.511 & 0.722 & 0.715 \\ 0.747 & 0.845 & 0.447 \\ 0.423 & 0.567 & 0.536 \end{bmatrix}$$

d. Determination the V matrix

$W_{n\times n} = W$, $V = D \times W_{n\times n}$

$$\begin{bmatrix} 0.345 & 0 & 0 \\ 0 & 0.345 & 0 \\ 0 & 0 & 0.31 \end{bmatrix} \begin{bmatrix} 0.511 & 0.722 & 0.715 \\ 0.747 & 0.845 & 0.447 \\ 0.423 & 0.567 & 0.536 \end{bmatrix} = V$$

$$\begin{bmatrix} 0.176 & 0.25 & 0.221 \\ 0.257 & 0.291 & 0.138 \\ 0.146 & 0.195 & 0.166 \end{bmatrix} = V$$

e. Determination the positive ideal options (A^+) and the negative ideal options (A^-):

$$\{(\max V_{ij} \mid j \in J), (\text{Min } V_{ij} \mid j \in J') \mid i = 1, 2, \dots, m\} = {}^+A$$

$$\{V_1^+, V_2^+, \dots, V_n^+\} =$$

$$\{(\text{Min } V_{ij} \mid j \in J), (\text{Max } V_{ij} \mid j \in J') \mid i = 1, 2, \dots, m\} = A^-$$

$$\{V_1^-, V_2^-, \dots, V_n^-\} =$$

$$\{0.146, 0.291, 0.138\} = \{\text{Min } V_{i1}, \text{Max } V_{i2}, \text{Min } V_{i3}\} = {}^+A$$

$$\{0.257, 0.195, 0.221\} = \{\text{Max } V_{i1}, \text{Min } V_{i2}, \text{Max } V_{i3}\} = A^-$$

f. Determination the amounts of d_i^+ and d_i^- by using the Euclidean method

$$1, 2 \dots n = i , \quad \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^+)^2} = d_i^+$$

$$1, 2 \dots n = i , \quad \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2} = d_i^-$$

$$d_1^+ = \sqrt{(0.175 - 0.146)^2 + (0.25 - 0.291)^2 + (0.221 - 0.138)^2} = 0.096$$

$$d_2^+ = \sqrt{(0.257 - 0.146)^2 + (0.291 - 0.291)^2 + (0.138 - 0.138)^2} = 0.111$$

$$d_3^+ = \sqrt{(0.146 - 0.146)^2 + (0.195 - 0.291)^2 + (0.166 - 0.138)^2} = 0.1$$

$$d_1^- = \sqrt{(0.175 - 0.257)^2 + (0.25 - 0.195)^2 + (0.221 - 0.221)^2} = 0.0986$$

$$d_2^- = \sqrt{(0.257 - 0.257)^2 + (0.291 - 0.195)^2 + (0.138 - 0.221)^2} = 0.1268$$

$$d_3^- = \sqrt{(0.146 - 0.257)^2 + (0.195 - 0.195)^2 + (0.166 - 0.221)^2} = 0.1236$$

g. Determination the amounts of cl_i^+:

$$cl_i^+ = \frac{d_i^-}{d_i^+ + d_i^-} , \quad 1 \le cl_i^+ \le 1 , \; i = 1, 2, \dots, m$$

$$cl_1^+ = \frac{d_1^-}{d_1^+ + d_1^-} = \frac{0.0986}{0.0969 + 0.0986} = 0.504$$

$$cl_2^+ = \frac{d_2^-}{d_2^+ + d_2^-} = \frac{0.1286}{0.111 + 0.1286} = 0.536$$

$$cl_3^+ = \frac{d_3^-}{d_3^+ + d_3^-} = \frac{0.1236}{0.1 + 0.1236} = 0.552$$

Results and Discussion

Determination the number of production in any production department

The results of the model by using the software Win Qsb are:

Table 7: The optimum number of production in any production department (Xi)

Poduction	(Xi^*)
1	X1=0.6
2	X2=1
3	X3=0.64
4	X4=1
5	X5=0.9
6	X6=1.5
7	X7=0.36

Table 7 shows that the optimum number of production in any production department (Xi).

The results described:

a. The optimum number of production in department 1, is: 0.6

b. The optimum number of production in department 2, is: 1

c. The optimum number of production in department 3, is: 0.64

d. The optimum number of production in department 4, is: 1

e. The optimum number of production in department 5, is: 0.9

f. The optimum number of production in department 6, is: 1.5

g. The optimum number of production in department 7, is: 0.36

h. The optimum total expected cost for production is: 30222 (Taman per hour)

Determination the optimum allocation of production operators to each work station based on the measured time (min) for production operations in a production cycle

Table 8: The finally table to optimum allocation of production operators to each work station by Hungarian method

Work Station / Operators Group	1	2	3	4	5
Group 1	1.47	0	0.267	0	0.276
Group 2	0	0.076	0	0.517	0.305
Group 3	105.88	1.271	0	0.523	0.397
Group 4	0.373	0.364	0.554	0	0
Group 5	0.191	0.632	0.093	0	0.076

Table 8 shows that the finally table to optimum allocation of production operators to each work station by Hungarian method. Table 9 shows that the optimum allocation of production operators to each work station based on the measured time (min) for production operations in a production cycle.

Table 9: the optimum allocation of production operators to each work station

Operator Groups	Work Station
Group 1	1
Group 2	2
Group 3	3
Group 4	4
Group 5	5

Based on the finally result for optimum allocation of production operators to each work station by Hungarian method, the optimum total expected time for production is: 537.339 (min)

Determination the optimum transportation amounts of raw materials

The initial solution for this transportation problem by using Vogel method is:

Table 10: The optimum initial transportation amounts of raw materials by using Vogel method

Supply	4	3	2	1	Work Station / Warehouse
15	13 (10)	22	2 (5)	12	1
25	22	11 (15)	9 (10)	14	2
5	20	18	16	2 (5)	3
45 / 45	10	15	15	5	Demand

(Costs in 100× Taman per hour)

Table 10 shows that:

a. The optimum initial transportation amount from warehouse 1 to work station 2 is: 5 pallets

b. The optimum initial transportation amount from warehouse 1 to work station 4 is: 10 pallets

c. The optimum initial transportation amount from warehouse 2 to work station 2 is: 10 pallets

d. The optimum initial transportation amount from warehouse 2 to work station 3 is: 15 pallets

e. The optimum initial transportation amount from warehouse 3 to work station 1 is: 5pallets

And based on table 10, the optimum initial total expected cost for raw materials transportation is:

$Z = 2 \times 5 + 13 \times 10 + 11 \times 15 + 2 \times 5 = 405 \rightarrow 405 \times 100 = 40500$ (Taman per hour)

Table 11: The optimum finally transportation amounts of raw materials by using Vogel method

4	3	2	1	Work Station / Warehouse
13 (10)	22	2 (5)	12	1
22 (0)	11 (15)	9 (10)	14 (0)	2
20	18	16	2 (5)	3

(Costs in 100× Taman per hour)

Table 11 shows that:

a. The optimum finally transportation amount from warehouse 1 to work station 2 is: 5 pallets

b. The optimum finally transportation amount from warehouse 1 to work station 4 is: 10 pallets

c. The optimum finally transportation amount from warehouse 2 to work station 2 is: 10 pallets

d. The optimum finally transportation amount from warehouse 2 to work station 3 is: 15 pallets

e. The optimum finally transportation amount from warehouse 3 to work station 1 is: 5pallets

Based on table 11, the optimum finally total expected cost for raw materials transportation is:

$Z = 5\times2 + 10\times9 + 10\times13 + 15\times11 + 5\times2 = 405\times 100 = 40500$(Taman per hour)

The results described:

a. The optimum number of production in department 1, is: 0.6

b. The optimum number of production in department 2, is: 1

c. The optimum number of production in department 3, is: 0.64

d. The optimum number of production in department 4, is: 1

e. The optimum number of production in department 5, is: 0.9

f. The optimum number of production in department 6, is: 1.5

g. The optimum number of production in department 7, is: 0.36

h. The optimum total expected cost for production is: 30222 (Taman per hour)

Determination the best transportation route, classifying material transportation routes from warehouses to assembly shop by using Topsis technique

Table 12: The finally table of classifying the transportation routes

Classifying	Alternative
third	Route: 1
second	Route: 2
first	Route: 3 *

Based on table 12:

a. The optimum raw materials transportation route is: 3

b.Transportation distance is: 43 meter

c. Supply Quality Status is: good

d. The average of transportation time is: 3 minutes

Conclusion

The aim of this study is determination the optimum production plan, the optimum transportation rate, the optimum transportation time, the optimum transportation distance, the optimum allocation of operational operators to work stations and the optimum total expected cost for production and transportation. in determination of the optimum transportation route, considered in terms of: supply cost, supply time, supply quality status. Determination the optimum production plan, production rate, the optimum allocation of operational operators, the optimum transportation route in terms of any indexes motive to enhanced power management decisions when faced with decision making in different situations due to market fluctuations and customers orders. This model can help to selecting of optimum supplier in a supply network or supply chain. Propose that this model use in real conditions with real data and limitations.

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