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Improving Production Line Efficiency By Using Production Line Balancing A Case Study In The State Company For South Gas Production

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Abstract

The research aims to use the (L.C.R) method to balance the production line in the General South Gas Company, because the balance in production lines has a very important role in raising production efficiency and reducing the time of delay and downtime, and it helps to distribute work items (tasks) to work stations Allocated on the production line, in a way that allows the completion of the production process with the least time and effort, the highest efficiency and the least idle time, and positively reflects on improving the efficiency of the production line.

This study is conducted on the production lines of the company under study in order to indicate the problems they suffer from and to prepare the inputs for the purpose of applying the method proposed by the research, and to reconsider the arrangement of the elements of the production line and its stations, provided that it does not violate the constraint of precedence and the time of the cycle in a way that serves the method presented for the application.(L.C.R) in balancing the production line and to the extent that it is compatible with the capabilities of the company under study. If the company seeks to reduce idle time and achieve optimum utilization(line efficiency).

Introduction

The activity of budgeting the production line is one of the important activities in the management of production and operations, and the budget is intended as an attempt to complete the work order to achieve the highest possible level of efficiency in the line and reduce costs to the lowest possible level, so there should be sufficient interest in this vital activity and division in a scientific and accurate way.

The issue of the internal arrangement (Layout) of the production facility is one of the important matters that should be taken care of by the management when starting the production process, due to its impact on the efficiency and effectiveness of the work that the company performs .

This issue is of great importance if the company produces according to the continuous modular production system, which needs a balancing process in its production lines, as the production budget is a special case of the internal arrangement of the product that ranks first in the order of priorities for the operators and designers of those lines. The total number of stations in terms of their durations, as the lack of balance leads to the equipment and workers in the faster stations stopping work While waiting for the output of the slower plants, the operations management should work to achieve the highest possible degree of balance according to the factory conditions.

2.Literature review

1.2 Concept of production line balancing

The issue of balancing the production line is one of the important issues in manufacturing, as it plays an effective role in achieving a continuous flow of work elements and achieving a desired rate of production for its money of economic return .

As it means balance (the flow of materials and goods from one production stage to another on a regular basis so that the organization does not face the problem of lost time or the bottleneck phenomenon that occurs when the production capacity in the previous stage is greater than the production capacity in the later stage or vice versa) [1], and is known as equilibrium A production line is (defining the tasks of line stations Assembly so that the completion time for all stations is equal) [2], and the line balance is also known as (the period of study of the assembly line, which roughly divides the work among workers equally in order to reduce the number of workers required in the production line) [3].

From the above, balancing the production line means that the time of each station is almost the same in other stations and idle time is the least possible, which leads to raising the efficiency of the production line and achieving a continuous flow of work elements .

2.2 Objectives of balancing the production line

The production line consists of a group of successive work stations or (work centers) as the tasks are distributed to them, and the workers on them accomplish those tasks assigned to each station until the final product is completed, so the production line should be well arranged and based on the requirements of succession precedence for each product in order to achieve Two main goals are: reducing costs and reducing idle time, and there are many goals that every industrial company seeks from behind balancing the production line The most important of them are [4]:

1.Ensuring a continuous flow of work items along the line.

Reducing the delay ratio to a minimum ..2

3.Reduce Idle time.

4.Determine the minimum number of workstations .

Increasing the efficiency ratio of personnel and

equipment.5 Achieving the desired production rate.6

Reducing material handling costs.7

Raise the morale of workers by not repeating work stoppages on the production line.8

9.Reducing the cost of one unit by continuing the production process and increasing the amount of production.

It is evident from the above that the goal of balancing the production line is to reduce idle time and increase the efficiency ratio of workers and equipment in order to make the budget achieve a continuous flow of work elements .

3.2 Handlers of product line imbalances

All companies face in some of their production lines some instances of imbalance, which leads to variation in the efficiency of workers, and the effect on the time required to complete the manufacturing process on a specific machine, and this affects the production capacity. Therefore, treatments for the production line imbalance should be available, represented by the following [5]:

1.Change the number of machines:

The general rule for achieving equilibrium is for the volume of production to be equal to the lowest common multiple of energy Productivity for different departments or stations.

2.Adjust factory standard times

The difference in the standard times required to produce one unit between the different stages of production is one of the important factors that lead to the occurrence of imbalance 3.Subscription of production lines:

Sometimes two or more production lines participate in one machine or one work site, when there is enough time so that it is possible to invest the full available energy and this method is adopted in the event that it is difficult to make changes to the standard time in the process that suffers from the phenomenon of wasted time .

From the above, dealing with the imbalance of the production line can lead to the adjustment in the standard times in all the various stages of production and through it the company has developed and addressed the imbalances in its production line.

There are many techniques and methods that are implemented manually, but this does not preclude their application on a computerEspecially if the problem is big and has many working elements, and for a wide number of stations. Here are some techniques The basic principles that have been applied in this field: [6]

1.Comsoal style

This method can be applied manually and is characterized by ease and simplicity, but it requires mathematical procedures that result in optimal or semi-optimal solutions to the problems of balancing production lines. Comsoal stands for Computer method for sequencing operation for assembly lines .

2.The CALB Program

It means computer aided line balancing. These programs were applied to both single and mixed models. So the solutions given by the Caleb program are almost perfect .

3.The ALPACA system

The use of this system by General Motors to plan and monitor the final assembly lines of cars, meaning (assembly planning and control activity). Its first implementation was in 1967 described as an interactive system for line balancing, which enables the user to transfer work from one station to another along the line, and gives the ability to balance the assembly line quickly.

4.The method of ranked positional weight (R.P.W)

This method depends on the weight of each work element in the list of weights, as the weight of each element is determined by adding the time of the work item plus all the elements that follow it, and the items with the most cumulative sum are assigned first, then the elements are allocated to the stations in the general order of their graduated location value in relation to the weights.

5.Largest-Candidate-Rule

This method depends on the size of the value of the elements, as it is characterized by ease and speed of understanding, and according to this method, the elements are allocated to the stations by selecting the elements

that are acceptable to the size of their value and placing them in the station for which the cycle time has been determined in advance.

The method of the largest candidate (L.C.R) will be applied in the research sample company to balance the production line in it, and among the most important criteria used in this method to balance the production line :

1. Line efficiency (LE)

It is the percentage of the total completion time of one unit of the product to the cycle time multiplied by the number of work stations. The line efficiency can be mathematically expressed by the following equation [7]:

$$LE = \frac{\sum te}{c.t \times N} \times 100$$

Whereas:

LE= line efficiency

te= work element time

actual Station **N=** number of

c.t= cycle time

delay(d)2. Balance

It is the percentage of the amount of idle time on the line due to non-completion of the fragmented work between the stations and this occurs when there is a defect or lack of knowledge of the distribution of work elements and can be calculated by the following equation [8]:

$$d = 1 - LE$$

Whereas:

d= Balance delay

LE = efficiency production line

3.idle time (Id)

It is a loss of the line and it usually occurs because the actual station time is not equal to the cycle time, that is, it is the difference between the actual station time and the cycle time and is calculated as follows [9]:

$$Id = c.t - st$$

Whereas:

Id = idle time

c.t= Cycle time

St= Station time

4.Smoothness index (SI)

It is a scale that expresses the flow and flow of materials on the production line, and when the flow index is equal to zero, then there is a complete balance and it can be measured by the following equation [10]

$$S1 = \sqrt{\sum \left(C.T - STe\right)^2}$$

Whereas:

SI = Smoothness index

STe= Station time

C.T = cycle time

Rate(RP) 5.production

The production rate is calculated through the cycle time, where there is a mathematical relationship between the cycle time on the production line and the production rate of the line, and the production rate for a single station or for the entire line can be extracted as follows [11]:

$$Rp = \frac{1}{C.T}$$

Whereas:

RP = Rate production

C.T=cycle time

As for the production rate of the entire line, it is determined at the lowest rate at the stations, which is the ruling station.

6.Line effectiveness(LEF)

It is an indicator of the extent of optimal utilization of the production line and is calculated as follows [12]

$$LEF = \frac{\sum Tp}{N \times C.T} \times 100$$

Whereas:
LEF = Line effectiveness

$\sum TP$ =actual production

N = number of station
C.T = cycle time

7.cost idle time (CIT)
It can be extracted as follows[5]:
The number of idle hours not utilized = Total idle time (time available for production at a certain cycle time $\frac{C.T}{60}$

8.services time(ST)
It is the time required to complete all the work distributed to the work stations and is calculated as follows [5]

$$ST = \frac{\sum Tp}{N}$$

Whereas:
ST = Services time
TP = production time
N = number of actual station

3.Research design

3.1 Study problem:

Through field follow-up and observation of the reality of the General Company for South Gas Production, it was found that the company lacked the application of scientific methods in balancing the production line and evaluating the performance of the current production line, which reflected negatively on the efficiency and effectiveness of the overall performance of the company. and the problem of the study with its broad scope was summarized in the following question:
How does budgeting the production line affect improving the production line efficiency in the State Company for Southern Gas?

3.2 Objectives of the study:

The research aims to use the method (L.C.R) in balancing the production line by distributing the time of activities (work items) to work stations.

4.The empirical inquiry

4.1 Analyzing the current reality in the company :

The research requires a brief presentation of the sequence of the production process in the General Company for Southern Gas Production, as its production is characterized by its modularity and requires organization and coordination between all its activities. Below is a summary of the sequence of stages of the production process (work stations) with all its requirements :
1.Preparing the raw material, examining it and conforming to the specifications.
2.Prepare the gas cylinder and reach the filling platform.
3.Fill the cylinder with gas.
4..Dimensions of the gas cylinder from the platform
5.Checking the cannula valve and its validity and closing.
6.The final full examination of the product.

Total work content = 72.27 minutes
The daily production time in the company is (8) hours, which is guaranteed by half an hour and lunch, and the production quantity is (33 tons) per day. Therefore, the net production time (8x60 minutes) = 480 minutes
Therefore, in analyzing the current reality of the company, the maximum time for the station will be relied, which is (60) minutes, which is Station No. (1) because the company does not adopt any scientific methods of work, and the number of actual stations in the company is (6) stations

$$LE = \frac{\sum te}{c.t \times N} \times 100$$

$$1) LE = \frac{72.27}{60 \times 6} \times 100 = \frac{72.27}{360} \times 100 = 20.07\%$$

$$2) d = 1 - LE$$

$$d = 1 - 20.07\% = 0.7993 \times 100 = 79.93\%$$

$$3) Id = \sum c.t - st$$

Then we collect the idle times of the stations

$$IdIetime = 57 + 58 + 58.73 + 58 + 56 = 287.73$$

minutes

Idle time for all stations on the line
Same numbers as in Idle Time but squaring it becomes Streamline

$$4) S1 = \sqrt{3249 + 3364 + 3449.2129 + 3364 + 3136}$$

$$= \sqrt{20011.212} = 141.46099$$

The highest output rate of the slowest station

$$5) Rp = \frac{1}{1.27} \times 60 = 47.24409 \times 8 = 377.952$$

To the stationThe lowest production rate the highest time

$$Rp = \frac{1}{60} \times 60 = 0.999 \times 8 = 7.999 \cong 8 \text{ unit}$$

6) Effectiveness Ratio = Total Actual Times Used x 100 Total lap times

$$= \frac{72.27}{360} \times 100 = 20.075\%$$

Table (1)

idle time for stations on the line

Number of stations / Times per minute	**1**	**2**	**3**	**4**	**5**	**6**
Time used	**60**	**3**	**2**	**1.27**	**2**	**2**
Cycle time	**60**	**60**	**60**	**60**	**60**	**60**
Idle time	**-**	**57**	**58**	**58.73**	**58**	**58**

7) The cost of holidays
Highest daily yield = Available time / cycle time

$$= \frac{8 \times 60}{60} = \frac{480}{60} = 8 \text{ unit}$$

Downtime Ratio = Total idle times of stations on the line x 100 Total lap times

Number of idle hours = idle time for all stations x (available time) / lap time / 60 minutes
Unused cycle time (60)

$$= \frac{(480)287.73}{\frac{60}{60}} = \frac{2301.84}{60} = 38.364 \text{ hour}$$

8) Average service time per workstation = total actual gas bottle time / number of stations

$$ST = \frac{72.27}{6} = 12.045$$

minutes

It is evident from the foregoing that the current reality of balancing the production line of the General Company for South Gas Production shows that the company suffers from inefficient use of available resources and wasted

time in addition to its lack of scientific methods in evaluating the performance of the production line, so one of the methods used in balancing the production line will be applied Draw conclusions about its application of what the company can in its followers as a basis in its work and assess its performance, which is the method of the largest candidate base (L.C.R).

4.2 Using the Large Filter Method (L.C.R) to balance the production line in the company:

$$C.T = \frac{480}{33} = 14.545$$ Unit

$$N = \frac{\sum te}{C.T} = \frac{72.27}{14.545} = 4.968 \cong 5$$ stationsThe theoretical number of stations

Whereas:

N= Number of stations

∑Te= Total time for activities

C.T= Cycle time

$$1)LE = \frac{\sum te}{C.T \times N} = \frac{72.27}{14.545 \times 5} \times 100 = 99.37\%$$

$$2)d = 1 - LE = 1 - 99.37\% = 0.63\%$$

Then collect idle times

$$3)IdleTime = 45.455 + 11.545 + 12.545 + 13.275 + 12.545 + 10.545 = 105.91$$

minutes idle time for all stations on the line

Table (2)

idle time for all stations on the line

Number of stations Times per minute	**1**	**2**	**3**	**4**	**5**	**6**
Time used	**60**	**3**	**2**	**1.27**	**2**	**4**
Cycle time	**14.545**	**14.545**	**14.545**	**14.545**	**14.545**	**14.545**
Idle time	**45.455**	**11.545**	**12.545**	**13.275**	**12.545**	**10.545**

Same numbers as in Idle Time but squared becomes Line Stream

$$4)S1 = \sqrt{2066.157 + 133.28702 + 157.37702 + 176.22562 + 157.37702 + 111.19702}$$

$$= \sqrt{2801.6206} = 52.930$$

Degree

The highest output rate of the slowest station

$$5)Rp = \frac{1}{1.27} \times 60 = 47.244 \times 8 = 377.952$$

unit

The lowest production rate and the highest time for the station

$$Rp = \frac{1}{60} \times 60 = 0.999 \times 8 = 7.999 \cong 8$$ unit

6) Effectiveness ratio = Total actual times used / Total cycle times x 100

$$\frac{72.27}{87.27} \times 100 = 82.8\%$$

7) The cost of holidays

Highest daily production = $\frac{480}{14.545} = 33$ Tons

The number of unused hours for the course time is = 14,545

$$= \frac{(480)105.91}{\frac{14.545}{60}} = \frac{3495.139}{60} = 58 \cdot 252$$ hour

8) Average service time per station

$$ST = \frac{\sum TP}{N} = \frac{72.27}{5} = 14.454$$

minutes

5. Conclusions :

The use of L.C.R method to balance the production line made the efficiency of the line up to (99.37%) compared to the current reality of the company, where the production line efficiency reached (20.07%). The (L.C.R) method recorded a delay rate of (0.63%), while the delay was (79.93%) before using the (L.C.R) method. The (L.C.R) method achieved fluidity, recording (52,930 degrees), as it reached (141,460 degrees) before applying the (L.C.R) method. The percentage of effectiveness of the (L.C.R) method was (82.8%), while the effectiveness of the line in the company was (20.075%). The L.C.R method achieved the lowest cost for the holidays, as it received (8), while the cost of the company was up to (33). The (L.C.R) method is the best criterion for the lowest service time for each station, as it recorded (14,454) minutes, while the service time in the company was (12,045) minutes.

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