C2 - EOQ Model - Example

A cement bag distributor sells 1000 bags of cement in a month. Cost of placing an order for him is \$60 and the cost of holding one bag in inventory is \$10. The lead is six days.

Find the optimum order quantity and the total annual cost.

Solution

$$EOQ = \sqrt{\frac{2UC_0}{C_H}}$$

$$= \sqrt{\frac{2(12000)(60)}{10}}$$

$$= 379.47 \text{ bags}$$

U = usage

$= 1000 \times 12$

$= 12000$ bags/year

$C_0 = \$60$

$C_H = \$10$

Six-day requirement $= \frac{1000}{30} \times 6$

$= 200$ bags $<$ EOQ (ok)

$$TAC = \text{Annual Order Cost} + \text{Annual Holding Cost}$$

$$= \left(\frac{U}{Q}\right) C_0 + \left(\frac{Q}{2}\right) C_H$$

$$= \frac{12000}{380} \times 60 + \frac{380}{2} \times 10$$

$$= \$\,3794.74$$

C3 – Demand Model – Example

O'Neill's sells each of its 'Hammer 3/2' wetsuit for \$ 180. The production & procurement cost per suit is \$ 110. Marketing department's forecast for sales is 3200 units.

What will be the demand for 'Hammer 3/2' during the spring season?

Solution

Given $p = \$180/\text{suit}$ (Price)

$c = \$110/\text{suit}$ (Cost)

$v = \$90/\text{suit}$ (Salvage Value)

Initial Forecast = 3200 Units

$$A/F \text{ ratio} = \frac{\text{Actual demand}}{\text{Forecast}}$$

$= 0.9975$ (Based on historical data)

Expected Actual Demand:

= Expected A/F ratio × Initial Forecast

$= 0.9975 \times 3200$

$= 3192$ Units

Standard Deviation of actual demand

$= 0.3690$

(Based on historical data)

Standard deviation of actual demand

$$= \text{Standard deviation of A/F ratios} \times \text{Forecast}$$

$$= 0.3690 \times 3200$$

$$= 1181 \text{ units}$$

O'Neill should choose a normal distribution with mean 3192 and standard deviation 1181 to represent demand for the 'Hammer 3/2' during the spring season.

C3 – Order Quantity – Example

For the previous example find the order quantity that maximizes expected profit.

Solution

Given, $p = \$180/\text{suit}$
$c = \$110/\text{suit}$
$v = \$90/\text{suit}$

Underage Cost, C_u = Price - Cost

$= 180 - 110$

$= \$70$

Overage cost, C_o = Cost - Salvage Value

$= 110 - 90$

$= \$20$

$$\text{Critical Ratio} = \frac{C_u}{C_o + C_u}$$

$$= \frac{70}{20+70}$$

$= 0.7778$

For, critical value $= 0.7778$, $z = 0.7823$

Order Quantity = Mean + z × standard deviation

$\Rightarrow Q = \mu + z \times \sigma$

$= 3192 + 0.7823 \times 1181$

$= 4116$ Units

C 4-Line Balancing-Example

Utilizations with demand of 125 units/week

	Worker 1	Worker 2	Worker 3
Activity time	792 sec/unit = 13 min/unit	648 sec/unit = 11 min/unit	450 sec/unit = 8 min/unit
capacity	$\frac{1}{13}$ unit/min = 4.61 units/hr	$\frac{1}{11}$ unit/min = 5.45 units/hr	$\frac{1}{8}$ unit/min = 7.5 units/hr
Process capacity	Min^m of (4.61, 5.45, 7.5) = 4.61 units/hr		
Demand	125 units/week = 125/35 units/hr = 3.57 units/hr		
Throughput	Min^m of (4.61, 3.57) = 3.57 units/hr (demand constrained system)		
cycle time (requested)	$\frac{1}{3.57}$ hr/units = 16.8 min/unit		
cycle time (designed)	$\frac{1}{4.61}$ hr/units = 13 min/unit		
Idle time/Unit	16.8−13 = 3.8 min/unit	16.8−11 = 5.8 min/unit	16.8−8 = 8.8 min/unit
Utilization	13/16.8 = 77%	11/16.8 = 65.5%	8/16.8 = 47.6%

Average Labor Utilization

$$= \frac{1}{3}(77 + 65.5 + 47.6)\%$$

$$= 63.4\%$$

So, No worker is fully utilized at the demand of 125 units/week.

There is an imbalance in the amount of work done by workers. Upon balancing the assembly line, the process capacity improves But the throughput does not change as the line is demand constrained.

Utilizations with demand of 200 units/week

If Requested Cycle Time < Design Cycle Time, we cannot produce at the requested level. So, the design is infeasible. Capacity must be expanded

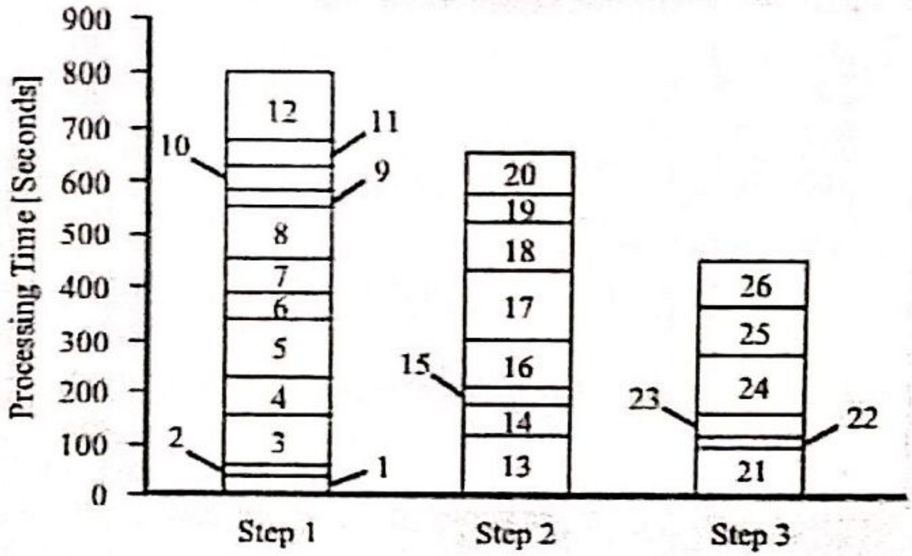
	Worker 1	Worker 2	Worker 3
Activity Time	13 min/unit	11 min/unit	8 min/unit
Capacity	$\frac{1}{13}$ unit/min = 4.61 units/hr	$\frac{1}{11}$ unit/min = 5.45 units/hr	$\frac{1}{8}$ unit/min = 7.5 units/hr
Process Capacity	Min^{m} of (4.61, 5.45, 7.5) = 4.61 units/hr		
Demand	200 units/weeks = 200/35 units/hr = 5.714 units/hr		
Cycle time (requested)	$\frac{1}{5.714}$ hr/unit = 10.5 mins/unit		
Cycle time (designed)	$\frac{1}{4.61}$ hr/unit = 13 mins/unit		
Idle time/Unit	13−13 = 0 min/unit	13 − 11 = 2 min/unit	13 − 8 = 5 min/unit
Utilization	$\frac{13}{13}$ = 100%	$\frac{11}{13}$ = 84.6%	$\frac{8}{13}$ = 61.5%

Average labor utilization

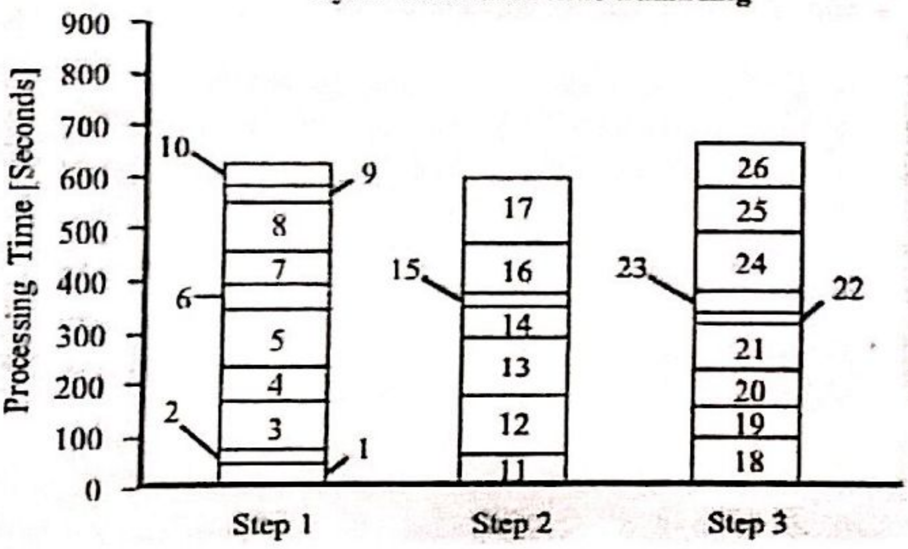
$$= \frac{1}{3}(100 + 84.6 + 61.5)\%$$

$$= 82\%$$

Cycle Time before Line Balancing



Cycle Time after Line Balancing



1. Prepare Cable
2. Move Cable
3. Assemble Washer
4. Apply Fork, Threading Cable End
5. Assemble Socket Head Screws
6. Steer Pin Nut
7. Brake Shoe, Spring, Pivot Bolt
8. Insert Front Wheel
9. Insert Axle Bolt
10. Tighten Axle Bolt
11. Tighten Brake Pivot Bolt
12. Assemble Handle and Cap
13. Assemble Brake Lever and Cable
14. Trim and Cap Cable
15. Place First Rib
16. Insert Axles and Cleats
17. Insert Rear Wheel
18. Place Second Rib and Deck
19. Apply Grip Tape
20. Insert Deck Fasteners
21. Inspect and Wipe Off
22. Apply Decal and Sticker
23. Insert in Bag
24. Assemble Carton
25. Insert Xootr and Manual
26. Seal Carton

Utilizations after Line Balancing with demand of 200 units week

	Worker1	Worker2	Worker 3
Activity time	10.383 min/unit	10.033 min/unit	11.083 min/unit
Capacity	$\frac{1}{10.383}$ unit/min = 5.78 unit/hr	$\frac{1}{10.33}$ unit/min = 5.98 unit/hr	$\frac{1}{11.083}$ unit/min = 5.41 unit/hr
Process Capacity	Min^{m} of {5.78, 5.98, 5.41} = 5.41 units/hour		
Demand	200 units/weeks = 5.714 units/hour		
Cycle Time (requested)	$\frac{1}{5.714}$ hour/unit = 10.50 min/unit		
Cycle Time (designed)	$\frac{1}{5.41}$ hour/unit = 11.083 min/unit		
Idle time/unit	11.083 − 10.383 = 0.7 min/unit	11.083 − 11 = 0.083 min/unit	11.083 − 11.083 = 0 min/unit
Utilization	$\frac{10.383}{11.083}$ = 93.7%	$\frac{10.033}{11.083}$ = 90.5%	$\frac{11.083}{11.083}$ = 100%

Average Labor utilization

$$= \frac{1}{3}(93.7 + 90.5 + 100)\%$$

$$= 94.7\%$$

With the rate of 5.41 units/hour weekly production in 35 hours is about (5.41×35)

$= 189$ Units

< 200 units

Therefore the system is capacity restrained.