

DR. ALVIN'S PUBLICATIONS

SEQUENCING

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INTRODUCTION

- This manuscript is an excerpt of concepts taken from Operations Management Textbook by Heizer, Render et al. (2017).

- There are Five Priority Rules for Sequencing:
 - First Come First Serve (FCFS)

 - Shortest Processing Time (SPT)

 - Earliest Due Date (EDD)

 - Longest Processing Time (LPT)

AN EXAMPLE

Job	Processing Time (Days)	Due Date (Days)
A	6	8
B	2	6
C	8	18
D	3	15
E	9	23

Find:

- Average Completion Time
- Utilization
- Average Number of Jobs in the System
- Average Job Lateness
- For:
 - First Come First Serve (FCFS)
 - Shortest Processing Time (SPT)
 - Earliest Due Date (EDD)
 - Longest Processing Time (LPT)

FIRST COME FIRST SERVE (FCFS)

- Sequence for FCFS = A – B – C – D – E

Sequence	Processing Time	Flow Time	Due Date	Lateness
A	6	6	8	0
B	2	(+2) 8	6	2
C	8	(+8) 16	18	0
D	3	(+3) 19	15	4
E	9	(+9) 28	23	5
Total	28	77		11

AVERAGE COMPLETION TIME FOR FCFS

$$\text{Average Completion Time} = \frac{\text{Total Flow Time}}{\text{Number of Jobs}} = \frac{77}{5} = 15.4 \text{ days}$$

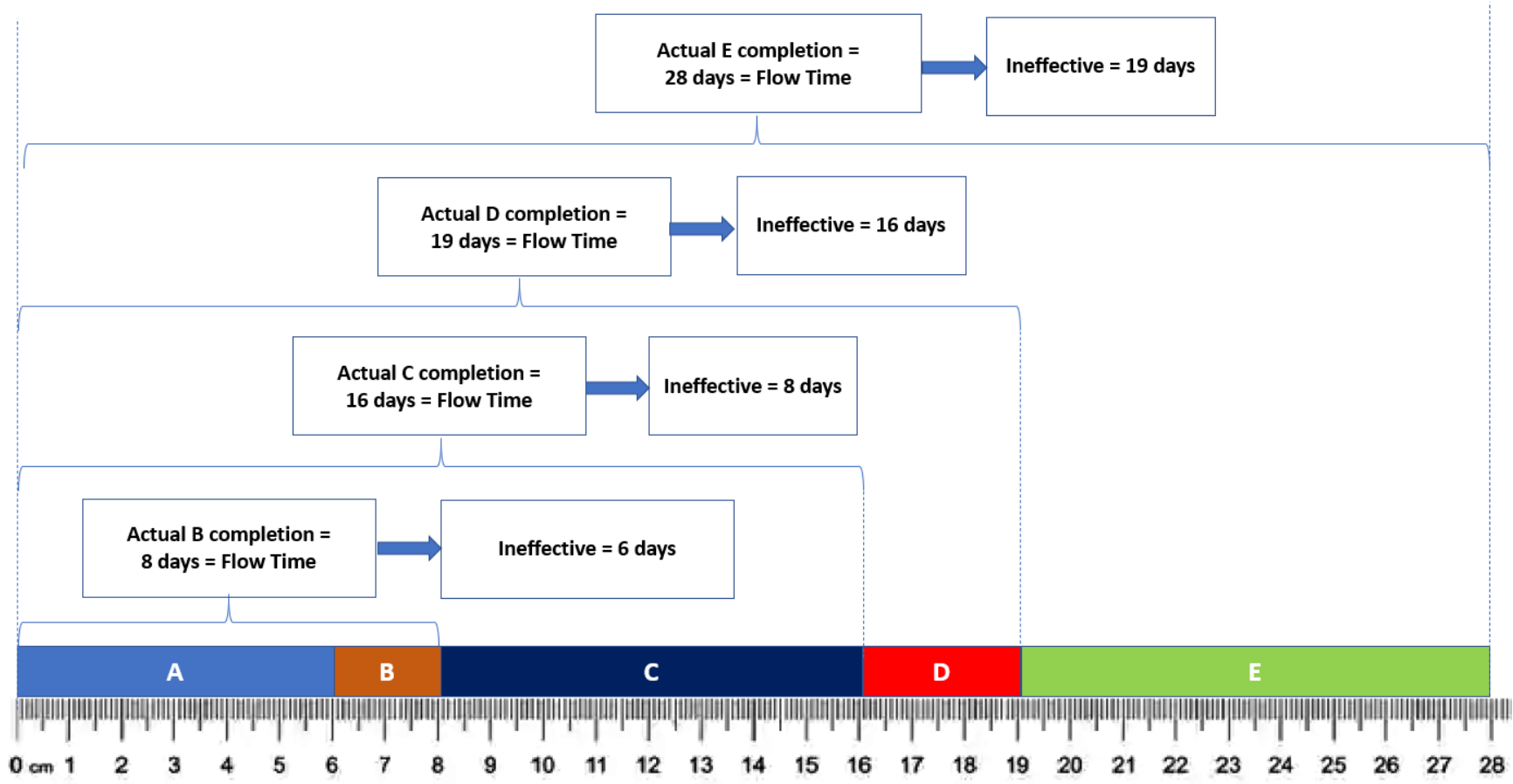
UTILISATION FOR FCFS

$$\text{Utilisation} = \frac{\text{Total Processing Time}}{\text{Total Flow Time}} = \frac{28}{77} = 36.4\%$$

What is the meaning of Utilization?

- Utilization = How well each individual job makes use of its time in the system.
- Utilization = Measure of how effective your system is.

- Utilisation = $\frac{\text{Sum of each individual job}}{\text{Total actual time required}}$
- Utilisation = $\frac{\text{Total Processing Time}}{\text{Total Flow Time}}$
- Where:
 - Total Processing Time = Sum of All Effective Days
 - Total Flow Time = Sum of All Effective + Ineffective Days
- Therefore Utilisation = $\frac{\text{Sum of All Effective Days}}{\text{Sum of All Effective + Ineffective Days}}$



AVERAGE NUMBER OF JOBS IN THE SYSTEM FOR FCFS

$$\text{Average Number of Jobs in the System} = \frac{\text{Total Flow Time}}{\text{Total Processing Time}} = \frac{77}{28} = 2.75 \text{ jobs}$$

What is the meaning of Avg No. Of Jobs In The System?

- Avg. No. of Jobs in the System = Avg. No. of Jobs Waiting = $\frac{\text{Total Actual Time Taken}}{\text{Sum of each Individual Job}}$

$$\text{Average Number of Jobs in the System} = \frac{\text{Total Flow Time}}{\text{Total Processing Time}}$$

Rearranging,

- (Avg. No. of Jobs in the System) × (Total Processing Time) = Total Flow Time

Where

(Total Processing Time) refers to "Per Effective Job" → Whole Sequence

Thus

$$(\text{Avg. No. of Jobs in the System}) \times (\text{"Per Effective Job" Time}) = \text{Total Time Taken (Eff. + Ineff. time)}$$

AVERAGE JOB LATENESS FOR FCFS

$$\text{Average Job Lateness} = \frac{\text{Total Lateness}}{\text{Number of Jobs}} = \frac{11}{5} = 2.2 \text{ days}$$

SHORTEST PROCESSING TIME (SPT)

Sequence	Processing Time	Flow Time	Due Date	Lateness
B	2	2	6	0
D	3	(+3) 5	15	0
A	6	(+6) 11	8	3
C	8	(+8) 19	18	1
E	9	(+9) 28	23	5
Total	28	65		9

AVERAGE COMPLETION TIME FOR SPT

$$\text{Average Completion Time} = \frac{\text{Total Flow Time}}{\text{Number of Jobs}} = \frac{65}{5} = 13 \text{ days}$$

UTILISATION FOR SPT

$$\text{Utilisation} = \frac{\text{Total Processing Time}}{\text{Total Flow Time}} = \frac{28}{65} = 43.1\%$$

AVERAGE NUMBER OF JOBS IN THE SYSTEM FOR SPT

$$\text{Average Number of Jobs in the System} = \frac{\text{Total Flow Time}}{\text{Total Processing Time}} = \frac{65}{28} = 2.32 \text{ jobs}$$

AVERAGE JOB LATENESS FOR SPT

$$\text{Average Job Lateness} = \frac{\text{Total Lateness}}{\text{Number of Jobs}} = \frac{9}{5} = 1.8 \text{ days}$$

EARLIEST DUE DATE (EDD)

Sequence	Processing Time	Flow Time	Due Date	Lateness
B	2	2	6	0
A	6	(+6) 8	8	0
D	3	(+3) 11	15	0
C	8	(+8) 19	18	1
E	9	(+9) 28	23	5
Total	28	68		6

AVERAGE COMPLETION TIME FOR EDD

$$\text{Average Completion Time} = \frac{\text{Total Flow Time}}{\text{Number of Jobs}} = \frac{68}{5} = 13.6 \text{ days}$$

UTILISATION FOR EDD

$$\text{Utilisation} = \frac{\text{Total Processing Time}}{\text{Total Flow Time}} = \frac{28}{68} = 41.2\%$$

AVERAGE NUMBER OF JOBS IN THE SYSTEM FOR EDD

$$\text{Average Number of Jobs in the System} = \frac{\text{Total Flow Time}}{\text{Total Processing Time}} = \frac{68}{28} = 2.43 \text{ jobs}$$

AVERAGE JOB LATENESS FOR EDD

$$\text{Average Job Lateness} = \frac{\text{Total Lateness}}{\text{Number of Jobs}} = \frac{6}{5} = 1.2 \text{ days}$$

LONGEST PROCESSING TIME (LPT)

Sequence	Processing Time	Flow Time	Due Date	Lateness
E	9	9	23	0
C	8	17	18	0
A	6	23	8	15
D	3	26	15	11
B	2	28	6	22
Total	28	103		48

AVERAGE COMPLETION TIME FOR LPT

$$\text{Average Completion Time} = \frac{\text{Total Flow Time}}{\text{Number of Jobs}} = \frac{103}{5} = 20.6 \text{ days}$$

UTILISATION FOR LPT

$$\text{Utilisation} = \frac{\text{Total Processing Time}}{\text{Total Flow Time}} = \frac{28}{103} = 27.2\%$$

AVERAGE NUMBER OF JOBS IN THE SYSTEM FOR LPT

$$\text{Average Number of Jobs in the System} = \frac{\text{Total Flow Time}}{\text{Total Processing Time}} = \frac{103}{28} = 3.68 \text{ jobs}$$

AVERAGE JOB LATENESS FOR LPT

$$\text{Average Job Lateness} = \frac{\text{Total Lateness}}{\text{Number of Jobs}} = \frac{48}{5} = 9.6 \text{ days}$$

COMPARISON

Rule	Avg. Completion Time (Days)	Utilization (%)	Avg. No. Of Jobs in System	Avg. Lateness
FCFS	15.4	36.4	2.75	2.2
SPT	13.0	43.1	2.32	1.8
EDD	13.6	41.2	2.43	1.2
LPT	20.6	27.2	3.68	9.6

CONCLUSION

1. No one sequencing rule excels on all criteria
2. SPT does well on **minimizing flow time** and **number of jobs in the system**
3. But SPT moves long jobs to the end which may result in **dissatisfied customers**
4. FCFS does not do especially well (or poorly) on any criteria but **is perceived as fair by customers.**
5. EDD minimizes **lateness**

REFERENCES

Heizer, J. H., et al. (2017). Operations management : sustainability and supply chain management.

ABOUT THE AUTHOR

Dr. Alvin Ang earned his Ph.D., Masters and Bachelor degrees from NTU, Singapore. He is a scientist, entrepreneur, as well as a personal/business advisor. More about him at www.AlvinAng.sg.