OM Basic Formulas

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Note: The formulas below are only a compilation of some of the more essential formulas used in OM. <u>These are not necessarily the only formulas you might need to use to solve an OM problem on an OM exam.</u> Also, under certain circumstances, they may need to be modified (e.g. if different resources in the process work different numbers of hours per week).

Process Analysis and Queueing

Let C = Capacity, CT =cycle time, FT = flowtime, u = utilization, IAT = interarrival time, *Takt Time* = = time between completions, λ = arrival rate, μ = capacity per server, m = # channels attached to a queue, CV_{IAT} = Coefficient of Variation of interarrival times, CV_{ST} = Coefficient of Variation of service times,

Process Analysis

(1) $Capacity_{process} = Capacity_{bottleneck}$

(2) $Capacity = 1/CT$; $Thruput = 1/Takt\ Time$;

(3) $u_{resource} = Thruput_{resource} / Capacity_{resource} = Labor\ Content_{resource} / Takt\ Time_{resource}$

(4) If arrival rate $\leq$ $\text{Capacity}_{\text{process}}$, Avg. Labor Utilization $= u = \dfrac{Labor\ Content \text{ per Item}}{\#employees\left(Takt\ Time_{process}\right)}$

(5a) Capacity of n Like Operations in Parallel = $n * Capacity_{operation}$

(5b) Capacity of unlike operations in parallel = $Min\left(Capacity_{op\_1}, Capacity_{op\_2}, ..., Capacity_{op\_n}\right)$

Inventory Build-up

Let *In*=inflow rate to an inventory, *Out*=outflow rate, S = supply, D = demand, I_a = inventory at time T_a, I_b = Inventory at time T_b, and I_{avg} = average inventory between T_a and T_b.
For any piecewise constant supply and demand from time T_a *to time* T_b*:*

(1) No blockage or starvation
$In = S; Out = D; I_b = I_a + (S-D)*(T_b - T_a); I_{avg} = (I_a + I_b)/2$

(2) Starvation
$In = S; Out = In; I_b = I_a = 0$

(3) Blockage
$Out = D; In = Out; I_b = I_a = I_{max}$

Queuing

(1) <u>Little's Law</u>: $FT = \dfrac{L_{AVG}}{Thruput}$, where L_{AVG} is the number of flow units in a process or sub-process.

Newsvendor Inventory

Let μ = expected demand, σ = std. deviation of demand, Q = an order quantity, ES = expected sales, ELS = expected lost sales, and ELI = Expected leftover inventory.

(1) Newsvendor optimal order quantity is Q such that:

$\Pr\left(D \le Q\right) = \frac{c_u}{c_u + c_o}$ where $c_u = P - C + G;\ c_o = C - V$, where P = retail price, C = wholesale cost, V = salvage (or clearance) value, and G = goodwill cost.

(2) $ELS = L(z)\sigma$, where $L(z)$ is the standard loss function for a normal distribution from the z-chart

(3) $ES + ELS = \mu$

$ES + ELI = Q$

(4) Fill Rate $= \frac{ES}{\mu}$

Project Management

CPM

Let ES = Earliest start time, EF = Earliest finish time, LS = Latest start time, and LF = Latest finish time for an activity.

(1) $Slack_{activity} = LF - EF = LS - ES$

PERT

Let a = the optimistic, m = the most likely, and b = the pessimistic estimates for the duration of an activity.

(2) For PERT, the expected duration of an activity and its variance are:

$\overline{T}_{activity} = \frac{a + 4m + b}{6}$ and $\sigma^2_{activity} = \left(\frac{b - a}{6}\right)^2$

This formula will also work for estimating individual activity costs.

Let $T_{project}$ = completion time of the project, T_{cp} = completion time of the critical path, $\overline{T}_{cp}$ = expected completion time of the critical path, and σ_{cp} = the standard deviation of the critical path.

(3) If the critical path for a project is a-b-c-…-n, then

$E\left(T_{project}\right) \approx \overline{T}_{cp} = \overline{T}_a + \overline{T}_b + ... + \overline{T}_n$ and Standard Deviation$\left(T_{project}\right) \approx \sigma_{cp} = \sqrt{\sigma_a^2 + \sigma_b^2 + ... + \sigma_n^2}$

(4) Project Cost: If $C_{project}$ is the cost of the project:

$E\left(C_{project}\right) = E\left(\text{Sum of the Cost of all activities in the project}\right)$ and

Standard Deviation$\left(C_{project}\right) = \sqrt{\text{Sum of all activity cost variances in project}}$