14+15+9 = 38 +3

The University of Jordan

The Department of Industrial Engineering

Quality Control Midterm Exam 2014-04-12

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Q1 (10 pts): A company faces a problem of high defect rates. Please select the proper SPC tool or missing phrase:

1. Three main types of defects were determined which differ in their severity. pareto chart
2. Historical data were collected about the defect frequencies. Check sheet
3. The potential causes of each defect are then defined. Cause and effect diagram
4. The relationship between each defect type and process factors settings is built. scatter diagram
5. The number of defects is monitored over 20 samples. attributes control chart
6. A large data set is collected, then a histogram is used to describe variation.
7. A control chart is established, a run of 8 points or more indicates an out of control.
8. In Phase II , the control chart is used to monitor future production.
9. The proper probability distribution for number of defects in a unit is poisson disdribution
10. The hardness can be monitored using variables control charts.
11. ~~probability plotting~~ (probability plotting) is used to test about a hypothesized distribution. → ~~(probability plots)~~
12. The control chart only detects assignable causes of variability.
13. Cause and effect diagram conveys information about potential cause of defects.
14. Motorola's six sigma results in 3,4 ppm.
15. Control charts prevent unnessecary process adjustment. ~~unnessecary~~
16. If the control chart includes unusual runs, it is concluded out of control.
17. Quality means fitness for use.
18. The attributes control charts are used to monitor number of nonconforming.
19. specifications limits are determined by product designers or customers.
20. Quality training is an example of prevention costs.

②

Q2 (30 pts): A team of five IE students were asked to conduct a project for quality control course. They visited a company that produces plastic bottles. It is estimated that:

Thickness (mm): normal (2, 0.04) (μ, σ^2) **specifications: 2±0.09**

Weight (gram): Normal (100, 4) (μ, σ^2) **specifications: 95±4**

Time to failure for the bottle: Exponential with mean failure rate 10^{-4}/ hr (β)

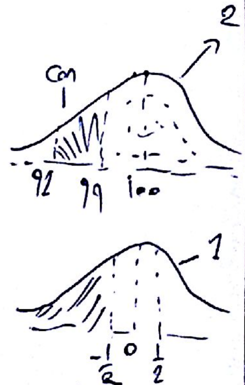
Time to failure for the measuring device: Weibull shape parameter = 2, scale = 120 hour. (β)

Number surface defects in a bottle: variance = 0.01. (λ)

(a) Calculate the probability that the bottle will be rejected due to excess weight. (3 pts)

$P(\text{fail}) = 1 - P(X \leq 99) = 1 - P\left(Z \leq \frac{99-\mu}{\sigma}\right) = 1 - P\left(Z \leq \frac{99-100}{2}\right) = 1 - P(Z \leq -0.5)$

$1 - (1 - P(Z \leq \frac{1}{2})) = 1 - (1 - 0.69146) = 0.69146$ (3)

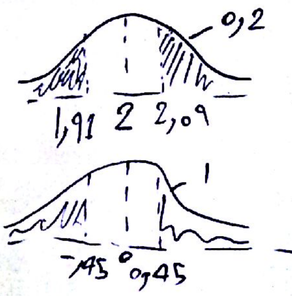


(b) Calculate the probability that the bottle will be rejected due to unacceptable thickness. (3 pts)

$P(\text{Failure}) = 1 - P(1.91 \leq X \leq 2.09) = 1 - (P(X \leq 2.09) - P(X \leq 1.91))$

$= 1 - \left(P\left(Z \leq \frac{2.09-2}{0.2}\right) - P\left(Z \leq \frac{1.91-2}{0.2}\right)\right) = 1 - (P(Z \leq 0.45) - P(X \leq -0.45))$

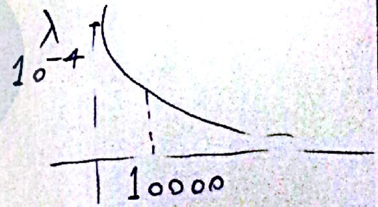
$= 1 - (0.67364 - (1 - P(Z \leq 0.45))) = 1 - (0.67364 - (1 - 0.67364)) = 0.65272$ (3)



(c) Calculate the probability that the bottle will fail before 10000 hour. (3 pts)

the failure before the mean

$P(X \leq \frac{1}{\lambda}) = 1 - e^{-1} = 0.63212$ (3)



(d) Calculate the probability that the measuring device will survive 120 hour. (3 pts)

$P(\text{survive}) = 1 - (1 - \exp(-(\frac{a}{\theta})^{\beta})) = e^{-(\frac{a}{\theta})^{\beta}} = e^{-(\frac{120}{120})^2} = 0.367879$ (3)

(e) Using parts (a) to (c), calculate the probability that the bottle will be accepted. (3 pts)

$P(z \leq -4.5)$

$1 - P(Z \leq 4.5)$ — approximately zero

$P(\text{accept}) = (1 - 0.65272)(1 - 0.63212)\left(1 - 0.69146 + P\left(Z \leq \frac{91-100}{2}\right)\right)$

$= (0.34728)(0.36788)(0.30854) = 0.039418$ (3)

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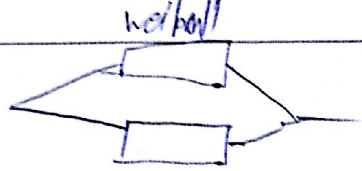

(f) Calculate the probability that a system of two parallel measuring devices will survive 120 hrs. (3 pts)

$p = 0.367879 \quad n = 2$

$P(x \geq 1) = P(x=1) + P(x=2) = \binom{2}{1}(0{,}367879)^1(1-0{,}367879)^1 + \binom{2}{2}(0{,}367879)^2(1-0{,}367879)^0$

$= 0{,}465088 + 0{,}135334 = 0{,}600422$

3

(g) What type of control charts are used to monitor thickness and number of surface defects? (3 pts)

To monitor thickness (variables control chart)

To monitor surface defects (attributes control chart)

3

(h) Calculate the probability that a bottle contains no defects. (3 pts)

$\lambda = 0{,}01$

$P(x=0) = \frac{e^{-0{,}01}(0{,}01)^0}{0!} = 0{,}99004$

3

(i) If the lot contains 50 units. The lot contains 2 nonconforming bottles. A random sample of 5 units is selected. It is decided that the lot is accepted if it contains at most one defective bottle. Calculate the probability that lot will be accepted. (3 pts)

N, D, n

$P(x \leq 1) = P(x=0) + P(x=1) = \frac{\binom{2}{0}\binom{48}{5}}{\binom{50}{5}} + \frac{\binom{2}{1}\binom{48}{4}}{\binom{50}{5}} = 0{,}80816 + 0{,}18367$

$= 0{,}99183$

3

(j) Calculate the probability in part (i) using proper approximation. Is this approximation satisfactory? Why? Why not? (3 pts)

(approximating to binomial) $p = \frac{D}{N} = \frac{2}{50} = 0{,}04$ | $n = 5$ | $P(x=0) + P(x=1)$

$\binom{5}{0}(0{,}04)^0(1-0{,}04)^5 + \binom{5}{1}(0{,}04)^1(1-0{,}04)^4 = 0{,}81537 + 0{,}16986 = 0{,}98523$

yes it's satisfactory because $\frac{n}{N} = \frac{5}{50} = 0{,}1 \leq 0{,}1$

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