UGBA 141
Discussion7

Agenda: Midterm Review II
- Quality
- Inventory

Check out Previous Reviews
- Lecture 12 - Midterm Flash Review
- Discussion 6 - Midterm Review I (Process)

Mar 4, 2022
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Reminder

- Pick up Homework 3 solutions in the front desk
- Vibe Check #2: bit.ly/poms22vibe2
  - Please help us improve the course 😊

- Prepare pen, standalone calculator, one (double-sided) cheatsheet to use in exam
- Exam officially starts at 12:40 pm but you are recommended to arrive earlier (12:30 pm) to get ready
- Submit Consulting team project preference by tonight 11:59 pm
- If you'd like to go over practice midterm solutions, join my OH after discussion

Quality Module: Knowledge Map

	Lecture Quality I	Lecture Quality II	Lecture Quality III
Concepts	metrics, variability, stochastic process control (SPC),	capability analysis, service quality	Toyota production system (TPS), lean operations
Practice	compute CL, LCL, and UCL in four types of control charts (mean, range, percentage and count), and interpret the results	compute capability index C_p and C_pk; defect probability	understand key elements in TPS (page 5 in Quality-III_Post.pdf)
Related HW2 Q	Q4, Q5, Q7, Q8	Q2, Q3, Q6	Q10
DIS 4	summary and problem 1	problem 2	-
Case	-	Ritz-Carlton	-

Quality Module

- What is the sample size?
  - The number of data points in a sample set

Tiny' s MBA Statistics

Samples of two from approximately 20 applicants in each cohort

Each year contains two samples

	GPA				GMAT			
Cohort	Sample 1	Sample 2	X-bar	R	Sample 1	Sample 2	p	c
2007	2.8	3.5			650	710		
2008	3.1	3.4			630	730		
2009	3.0	3.6			670	690		
2010	3.2	3.6			740	670		
2011	3.1	3.8			720	680		

One sample set for each year

Sample size = 2

- Estimated std dev in capability analysis
  - It is calculated with data points from all samples

Quality Module: Control Charts

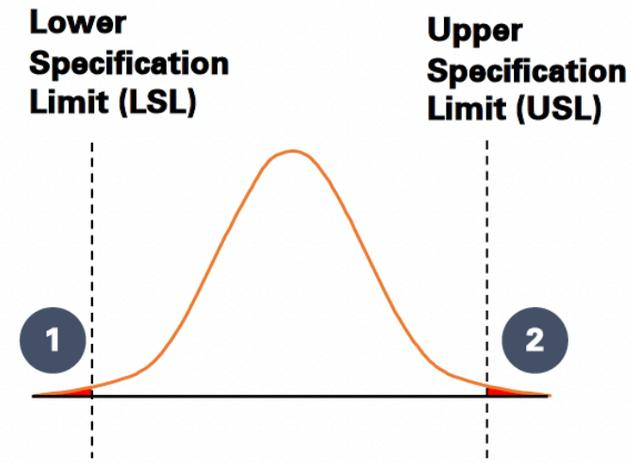
- Basics
  - Compute CL, LCL, UCL of four control charts
  - Read Table of Control Charts Constant
- LCL and UCL might need to be truncated
  - LCL cannot be negative in general
  - UCL of percentage p cannot be larger than 1
  - UCL of count c cannot be larger than the sample size

Quality Module: Capability Analysis

- The capability index is C_p or C_{pk}?
  - C_p is for centered process, C_{pk} is for off-centered process
  - C_p is actually a special case of C_{pk}
- What do “centered” and “off-centered” mean?
  - It means whether the mean $\overline{X}$ is at the center of the upper/lower specification limits [LSL, USL]

Quality Module: Defect

- Probability of defect
  - Page 8 of Quality-II-Post.pdf



- Revisit HW3 Q2

Berkeley Bowl sells cherry tomatoes to local fast food restaurants. The diameter of a tomato is on average 26 mm, with a standard deviation of 3 mm. The upper and lower specifications limits that they are given are, respectively, 32 mm and 20 mm.

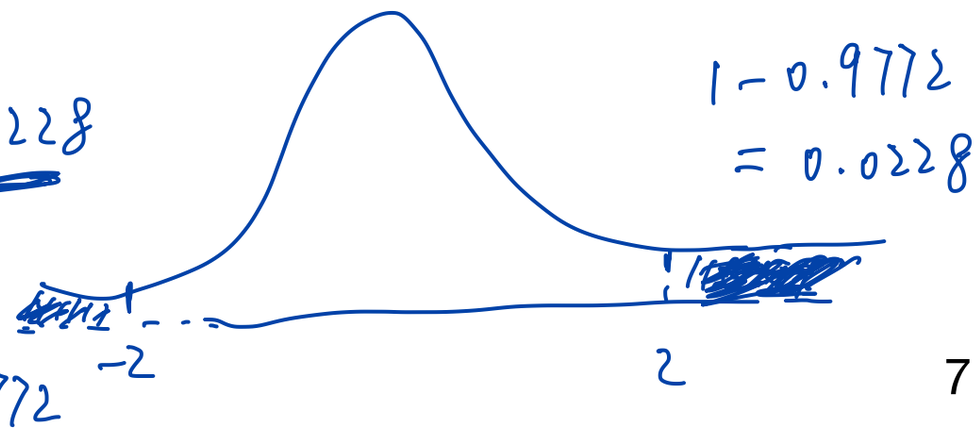
Q2. What percentage of their tomatoes are within the specification limits? *(Answer in either XX.XX% or 0.XXXX format)*

Read standard normal table to get these two probabilities

- Prob(below LSL) = Prob below z-score -2 (=(20-26)/3)
- Prob(above USL) = Prob above z-score 2 (=(32-26)/3)
- Prob of defect = Prob(below LSL) + Prob(above USL) = .0228 + (1- .9772) = 0.0456

below $\frac{LSL - \mu}{\sigma} = -2 \rightarrow 0.0228$

above $\frac{USL - \mu}{\sigma} = 2 \rightarrow 0.9772$



Inventory Module: Knowledge Map

	Lecture Inventory I	Lecture Inventory II	Lecture Inventory III	Lecture Emerging I
Concepts	inventory turns, EOQ, (Q,R)	(P,T), Newsvendor *check out recorded video by professor	Zara, risk pooling	sustainability, Starbucks
Practice	(a) calculate different costs, EOQ; (b) calculate Q, R; (c) inventory turns and days of supply	(a) newsvendor order quantity; (b) calculate P, T	understand the idea of risk pooling	understand sustainability practices
Related HW3 Q	(a) Q1, Q2, Q3, Q6, Q7; (b) -; (c) Q10	(a) Q4, Q5 (b) Q8, Q9	-	-
DIS	DIS 5 problem 1,2	DIS 6 problem 1,2	-	-
Case	-	-	Zara	Starbucks

Inventory Module

- When to use which inventory model?
  - Some simple criteria: No demand uncertainty ➡️ EOQ, single period ➡️ Newsvendor

	EOQ	**(Q, R)**	**(P, T)**	**Newsvendor**
Replenish	Yes	Yes	Yes	No
Terms of interest	Order quantity Q	Order quantity Q Reorder point R	Period length P Target level T	Profit-maximizing quantity Q^*
Context	Constant demand and no lead time	Uncertain demand and lead time	Uncertain demand and lead time	Uncertain demand

Inventory Module: **Formulas**

- Understanding the (Q,R) and (P,T) formula
  - The order quantity in (Q,R) is calculated by EOQ by default, but the order quantity can be exogenously affected, for example, by truck capacity in HW3 Q6.
  - The order quantity in (P,T) is not necessarily T: it is T minus number of existing inventory
  - Z-score is obtained from the service level and reading the standard normal table

- Mean and std dev of aggregate demand
  - Probability fact: Given mean μ and std dev σ of single period demand, the mean and std dev of aggregate demand over n periods are $n\mu$ and $\sqrt{n}\sigma$ respectively
  - For (Q,R), n is lead time; For (P,T), n is lead time + period length

Inventory Module: Costs

- Different costs in EOQ
  - Purchasing cost
  - Ordering cost
  - Setup cost
  - Inventory cost/ holding cost/ carrying cost

- Holding cost per unit
  - *"holding cost are 25% per year"*
  - It means that the holding cost per unit is 25% of the purchase cost per unit

- Total holding cost $h \times Q/2$
  - The average inventory in stock is $Q/2$, not D
  - Why? See the inventory profile figure of EOQ (Page 21-22 in Inventory-I-Post.pdf)

Inventory Module: **Formulas**

- Newsvendor: from critical ratio $G/(G+L)$ to order quantity Q^*
  - If demand follows discrete distribution (HW3 Q4)

Demand	Probability
0	0.05
5	0.10
10	0.10
15	0.20
20	0.25
25	0.15
30	0.10
35	0.05

  - If demand follows standard normal distribution (HW3 Q5)

- Average inventory turns versus Days of supply
  - Analogy: Frequency versus Period

Process Module: Knowledge Map

	Lecture Process I	Lecture Process II	Lecture Process III	Lecture Process IV
Concepts	efficiency frontier; flow unit; process flow diagram	process capacity; bottleneck; flow rate; utilization; labor productivity (idle time, labor content, labor utilization, cost)	rework; flow unit-dependent process	cranberry case
Practice	a) identify efficiency frontier; b) read process flow diagram	a) compute capacity, flow rate, cycle time; b) compute labor productivity; c) compute time to make X units;	a) process capacity with rework; b) implied utilization in flow unit-dependent process; c) process choice	inventory buildup
Related HW1 Q		a) Q1, Q2, Q3; b) Q4, Q5, Q6, Q7; c) Q10, Q11	a) Q8; b) Q9	Q11, Q12
DIS	DIS 1	DIS 2	DIS 3	DIS 3
Case		Kristen's cookie	Beleza Natural	National Cranberry

* Recap here for completeness, see more review of Process in Discussion 6

Overview

- From Midterm Flash Review in Lecture 12

Midterm Possible Topics

Process I	efficient frontier + process basics
Process II	process analysis + labor productivity + Kristen's Cookie
Process III	rework + flow-dependent + process choice + Beleza
Process IV	inventory buildup + NCC + automation
Quality I	metrics + variations in processes + SPC
Quality II	capability analysis + Ritz-Carlton + service quality
Quality III	Toyota Production System + lean operations (no case)
Inventory I	inventory turns + EOQ + (Q,R) model
Inventory II	(P,T) model + newsvendor model
Inventory III	Marks Spencer & Zara + risk pooling strategies
Emerging I	guest speaker + sustainability + Starbucks

- Only a subset of these topics will appear in the actual exam

Take-away

- Review for Cases
  - Focus on concepts discussed in class, no need to spread beyond the class
- Careful with calculation accuracy
  - Keep enough decimals for intermediate calculation
  - For final answer, read instructions for keeping certain number of decimals or rounding up/down or otherwise.
  - Remember unit conversions, for example different time periods
- Read question carefully
  - Hightlight important assumptions
  - Acknowledge that some information might not be used in the end
  - Multiple knowledge concepts might be tested in one question
- The exam is much less tricky than HW 👀