

vpmittal

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Question 1: Don’t Get Clogged

[25 pts] ClogsAreUs is a company that builds and designs clogs for the American market. The clogs are made from spruce wood sent directly from a supplier in Canada. The wood costs ClogsAreUs $85 to purchase per pair of clogs, and each order ClogsAreUs places costs $750. The lead time to receive each order is 0.25 years. The annual demand for clogs is normally distributed with a mean of 2,000 and a standard deviation of 40. The holding costs is calculated using an annual interest rate of 20%. Assume that clogs are backordered when out of stock with an associated cost of $40.

c = 85 per pair of clogs

k = 750

τ = 0.25 years

mean demand = 2000

demand variation = 40

i = 20% = 0.2

p = 40

1. [4 pts] Compute the mean and standard deviation of demand during the lead time.

1. [5 pts] Find the optimal (Q, R) policy.
2. [4 pts] Determine the safety stock.
3. [3 pts] What is the expected annual holding, setup, and penalty costs associated with this product?
4. [3 pts] What is the proportion of order cycles in which no stock-outs occur?
5. [3pts] What is the proportion of demand that is unmet?
6. [3pts] If ClogsAreUs aims for a 98% Type 2 service level, does it over or under-estimate the penalty cost?

Question 2: Let it Slide!

[25 pts] At a water park there is a 250-meter slide that is the main attraction. Enthusiastic children (of age 7 and above) and adults alike line up to experience the thrill and they arrive as a Process process of rate 8 people per 10 minutes. The water slide is wide enough for one person at a time, and for safety the park does not allow an adult accompanying a child. The duration of each slide taken (consider the time from person starting the slide till the next person could slide) is exponentially distributed with a rate of 10 people every 10 minutes. Assume that the queue can build to infinite.

(a) [5pts] What is the average number of users of the slide in the system? What is the average waiting time in the system?

(b) [5 pts] What is the average number of users in the queue? What is the average time in the queue?

(c) [5 pts] Now consider the situation where the inter-arrival time is constant and is given by 1 minute. The slide time required by each user is also constant and equal to 30 seconds. What is the mean waiting time per user in this case?

(d) [5pts] Suppose that there is increased popularity in the water slide, now with an arrival rate of 10 people per 10 minutes. As a result, the water park builds another identical slide. The slides are now side by side and customers take a single flight of stairs to get to the platform where they would randomly choose to go to either slide with equal probability. Due to other efficiencies, the slide times are now exponentially distributed with rate 12 people every 10 minutes for each slide. What is the average waiting time in the system?

(e) [5 pts] The water park is so successful with two slides that they are considering opening an entirely new water park where they would have six slides that serve users in one line. The management estimates that the inter-arrival time of users follows a uniform distribution between 3 and 9 minutes. The slide time will also follow a uniform distribution, but between 0.5 minute and 2 minutes. What will be the average time in the new water park six-slide system?

Question 3: All About the Air

[25 pts] When the deadly Northern California wildfire was burning in November 2018, it was hard to get hold of an air purifier in stores or online. Rajiv operated a small electronic appliance store in Mountain View and was left with one GermGuardian AC4825 model. He recognizes that it is a business opportunity and would like to, within acceptable moral bounds, adjust the price according to demand a little bit. He expects that one customer will arrive in the next hour with a willingness to pay that is uniformly distributed between 0 and 200. He also expects that, in the next hour, a different customer will show up whose willingness to pay is distributed uniformly between 0 and x.

(a) [10pts] How should Rajiv price the air purifier for each hour?

(b) [8 pts] For what value of x is the price during the first hour lower than the price during the second hour?

Suppose that Rajiv found a second identical air purifier (unused) from the back of his storage room at home. During the first hour, he expects one customer to arrive whose willingness to pay is drawn independently from U [0, 100]. During the second hour, a different customer is expected to show up whose willingness to pay is drawn independently from U[0,300]. During the third hour, yet another different customer is expected to show up whose willingness to pay is drawn independently from U[0,200]. If he doesn’t find a customer after the first three hours, he will sell it at the regular price of pr = $85.

(c) [7pts] How should Rajiv price the second air purifier in this case? It is enough to give the formula. Do NOT try to solve the optimization problem numerically.

Question 4: Farm to Bakery

[25 pts] Imagine a two-firm supply chain that consists of a grain farmer and a bakery. The farmer produces top of the range grain and you oversee and manage the operations of the company. Currently the demand for grain is uniformly distributed between 0 and 1,000 pounds per year. The production and distribution cost of the grain is $4,000 per pound. As it stands now, the farmer sells his grain to the Kings Bakery at a cost of $6,000 per pound and the Bakery sells to hungry customers at a retail price of $9,000 per pound. Assume there is no salvage value.

(a) [10pts] What is the optimal order quantity from the baker’s perspective? What are the expected profits for the farmer and the retailer?

(b) [10 pts] How do your answers to part (a) change if the farmer decides to stop selling to the baker and instead sets up his own bakery, i.e. have a vertical integration?

(c) [5pts] Returning to the two-firm model from part (a), if you were given the opportunity to set up a revenue-sharing model, what is the optimal relation between the up-front fee and the revenue-sharing percentage value?

Question 5: Map it Out

[25 pts] You are the manager of a technology company that provides detailed urban maps, including high- fidelity images of buildings, trees, and other structures. You are considering a novel method of using industrial drones, with a suite of hyper-spectral cameras mounted on its underbelly. These cameras (and advanced post-processing algorithms) will provide high quality images. You hope to deploy the camera system before your primary competitor, Google, does so first.

After buying a stabilization-control component for the camera, you discover that the component’s manu- facturing quality is questionable. The component has two possible manufacturing quality levels (weak or strong). If the component is weak, it will cause the camera to fail before the data collection is completed. You believe there is a 30% chance the component is weak. If the component is strong, the camera will work successfully through the full data collection campaign.

In this problem, your only concern is the stabilization control component. You face the decision of whether to use or discard the component in two cases: with or without the benefit of a test. If you discard the component, you can obtain only a fraction of the image data (an outcome valued at $500K). If you use the component, and it fails, you’ll get no useful image data (an outcome valued at $0). However, if you use the component, and it survives the full data collection campaign, you will get a complete set of image data (an outcome valued at $1M). You are risk neutral.

Jiaming, employed in an aviation systems group within the aero-astro department of a local university, has offered to help by providing a test for the component. Jiaming can provided a set of flight tests:

Component Testing: The camera component has two possible states (weak or strong). For a strong com- ponent, the test will correctly predict the state of the component with a probability of 0.7, and incorrectly predict the component’s state with a probability of 0.3. For a weak component, the test will correctly predict the state of the component with a probability of 0.9, and incorrectly predict the component’s state with a probability of 0.1. The test costs $10K.

(a) [10 pts] Before considering the stabilization control component test, build a decision tree to determine whether you should use the component or discard it without testing it. What is the best alternative?

(b) [10 pts] Now assume that you can obtain the component test before deciding whether to use or discard the stabilization-control component. Draw the full set of decision trees for your decision of whether to purchase the component test. Should you buy the test? If so, what is the most you would be willing to pay for it? If not, by how much would the aviation systems group have to reduce the price for you to consider it?

(c) [5 pts] If the aviation systems group offered a perfect test for the component, how much would you be willing to pay for it?

Question 6: OM++

[25 pts] Answer briefly the following questions.  
(a) [5 pts] List the 5 principles of Lean Manufacturing.

(b) [10 pts] Describe how you would move your furniture to a new house using a Flow proc

(c) [5 pts] Explain why implementing supply chain contracts, like real options, revenue sharing contracts or buy-back contracts can be difficult in practice.

(d) [5 pts] When evaluating the trade-offs between the charge-coupled device (CCD) imagers versus com- plementary metal-oxide-semiconductor (CMOS) imagers for space imaging, the differences in the CCD versus CMOS industrial base result in relative differences in both fixed cost and marginal unit cost. What are those relative differences?