CE 311S Lab 3
Estimating Construction Labor Costs Using a Random Variable Model

Purpose

In this laboratory you will investigate how actual labor costs for construction jobs compare with the costs predicted by a statistical model.

Introduction

You are the cost estimator for a small subcontractor and are preparing a bid for a city project. Your bid (an estimate of the cost, time, and materials required to complete the project) depends on your estimate of the labor costs at the time that the project is constructed. The cost of labor varies from project to project, depending on the location of the job, whether you have to hire union or non-union labor, the season, and the state of the construction market and overall economy. Typically, the city awards projects to the lowest bidder. Therefore, you will need to be as competitive as possible in order to win the work. However, you do not want to underestimate the costs, or you will lose money on the project.

Although it is difficult to predict exactly what the labor cost will be at the time of construction, your firm has developed a model to predict labor cost based on its past experience. This theoretical model, shown in Figure 1, is represented as a probability density function (pdf). The lower and upper bounds of the cost distribution are set according to what you, the contractor, believe are reasonable. A typical job for your firm requires a crew of five laborers, and the crew works 40 hours per week.

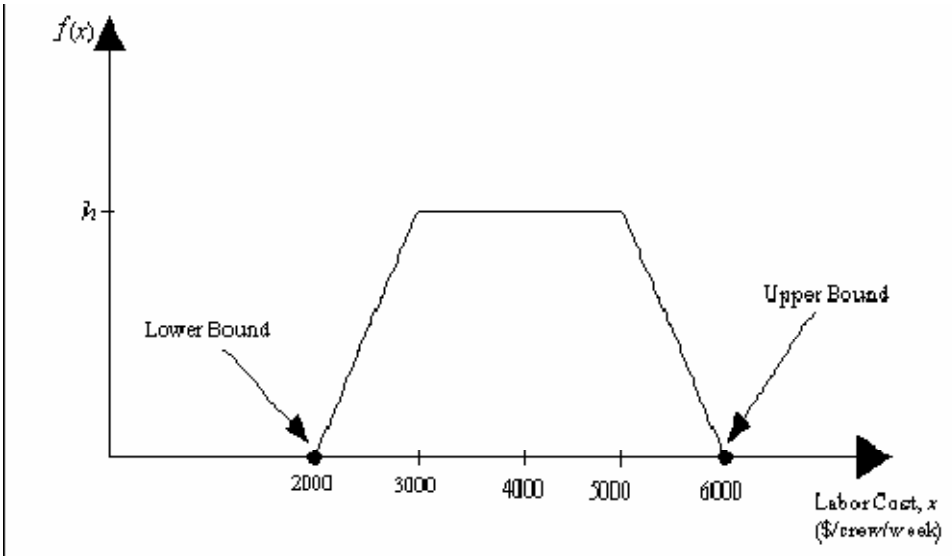


Figure 1: Theoretical pdf for labor cost

You will run 50 experiments that simulate actual labor costs for different jobs based on the lower and upper bounds of labor cost. A single experiment represents the actual labor cost for one particular construction job; therefore, you and your partner will be gathering cost data from 50 different jobs. You are interested in how the actual labor costs on construction jobs compare with your predicted labor costs.

Procedure

1. Run the program "Labor Cost.exe" and click the run arrow (➪) in the toolbar.
2. Enter the values for the Lower Bound ($2000/crew/week) and the Upper Bound ($6000/crew/week) of the labor cost.
3. Click on the "Next Trial" button to run a simulation and record the actual labor cost in Table 1. Repeat until you have labor costs for 50 jobs (it may help to split the task in half among your group).
4. Enter the results into the Excel spreadsheet provided with the lab program file.
5. Answer questions (1 through 7).

Questions

1) Define the random variable you are evaluating in this laboratory. Why is it a random variable? Is it discrete or continuous? Why? (10 pts)

2) Using the theoretical model shown in Figure 1, calculate the maximum height of the pdf, *h*, and the expected labor cost, E(*x*). (10 pts)

(Hint: Area under a pdf should be equal to 1, i.e., $\int_{-\infty}^{\infty} f(x)dx = 1$. Also, E(x) = $\int_{-\infty}^{\infty} xf(x)dx$.)

3) a) Calculate the sample mean of the actual labor costs, $\bar{x}$,using your data. (7.5 pts)

b) How does the sample mean, *x*, compare with the expected labor cost, E(*x*)? (7.5 pts)

4) a) With what frequency does the simulated labor cost, x_i, exceed the expected labor cost, E(x)? (5 pts)

b) Using the theoretical model (i.e. Figure 1), calculate the probability that the actual labor cost for a job, x, exceeds the expected labor cost, E(x). Compare this theoretical probability with the observed frequency from (4a). (5 pts)

(Hint: $P(x \geq E(x)) = \int_{E(x)}^{\infty} f(x)dx$)

5) (15points)

a) Plot the frequency distribution of the actual labor costs as a histogram using the Excel spreadsheet Lab3.xls.Group the data into bins with widths of \$500/crew/week. (for example, an actual labor cost of \$5,234/crew/week would be grouped in the \$5,000 < $x \leq$ \$5,500 bin.) (please attach printout of histogram)

b) Plot the pdf of the theoretical model on the same graph as the frequency density distribution from (5a). You can do this plot by hand.

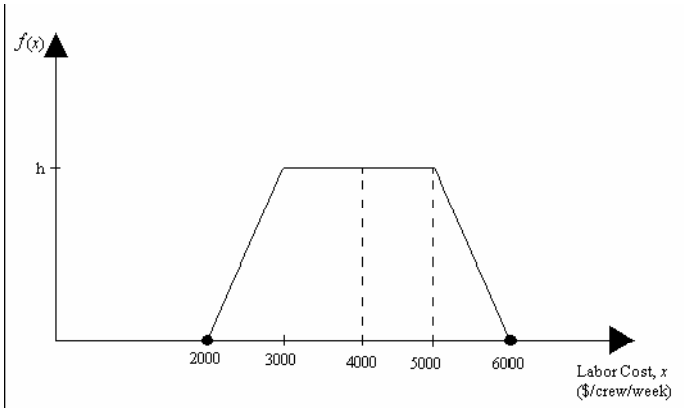
c) Discuss the similarities and differences between the pdf of the theoretical model and the frequency distribution.

6) a) What labor cost would you use in your next bid? Explain how you determined this cost and why you will use it. (5 pts)

b) What are some advantages and disadvantages in using a labor cost near the lower bound? (5 pts)

c) What are some advantages and disadvantages in using a labor cost near the upper bound? (5 pts)

7) If you **know** that labor on a particular job will cost more than \$4000/crew/week, use the theoretical model to calculate the probability that the actual labor cost, x, will be less than \$5000/crew/week. Show all work. (15 pts)



Extra Credit (+ 5 pts): Calculate the variance of the pdf shown in Figure 1.

Table 1: Actual Labor Costs (10 pts)

Job #	Actual Labor Cost ($)	Job #	Actual Labor Cost ($)
1		26	
2		27	
3		28	
4		29	
5		30	
6		31	
7		32	
8		33	
9		34	
10		35	
11		36	
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24		49	
25		50	