Lorex Pharmaceuticals Case

i. Summary and Problem Statement

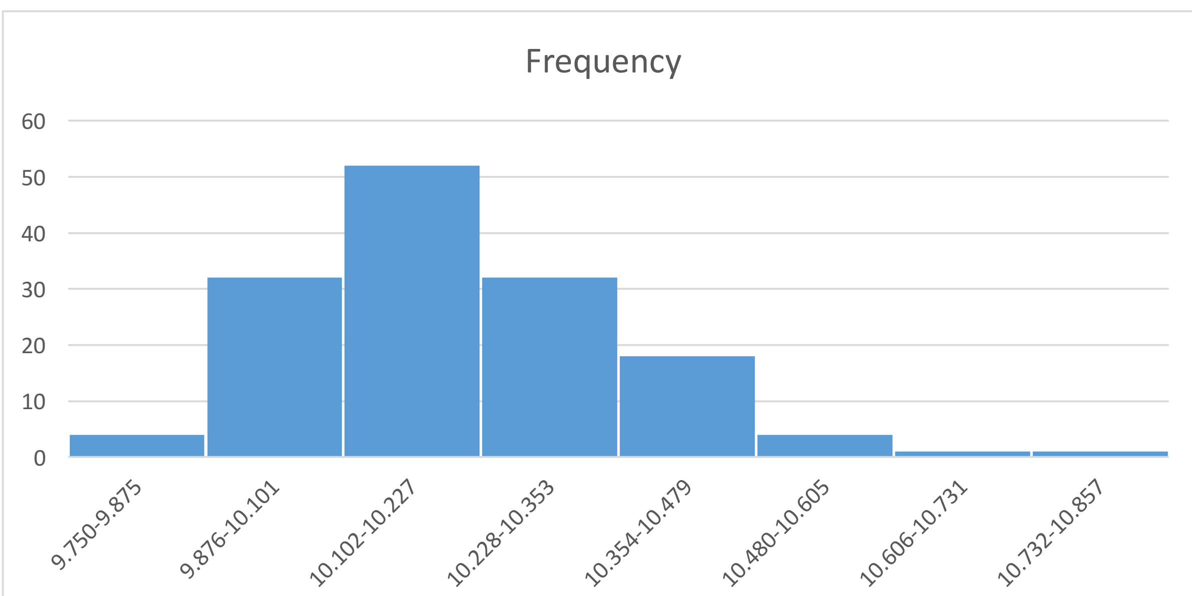
Lorex Pharmaceutical produces Linatol which is a medicine for treatment of high blood pressure. The medicine is sealed in 10 oz. bottles, packed in cases of 12 bottles each. The wholesale price for the medicine is set to $186 per case.

Linatol is blended in 5000 liter batches and the product is bottled on the company's semiautomatic filling lines. The company expects to average 500 cases of the medicine over an 8-hour shift. The filling line is operated by 2 employees who earn a total of $12.80 per hour. Linatol also has an overhead maintenance charge of $89.50 per hour. Furthermore, the cost of the materials used by the filling line is estimated to be $1.10 per bottle.

All Linatol bottles are to be filled up to a 10 oz. requirement. If the bottles are under-filled, a team of filling-room attendants periodically label the under-filled bottles as *seconds* and these bottles are sold to secondary markets at a price of $148.80 (80% of the normal price). Each attendant is capable of labeling and packing about 12 cases per hour and these attendants earn $8.50 per hour. The task of the quality assurance manager for the manufacturing division of Lorex is the selection of a target amount to which each of the 10 oz. bottles of Linatol should be filled.

ii. Approach

A plot below shows that the distribution of the sampled filling test results (from the dataset):

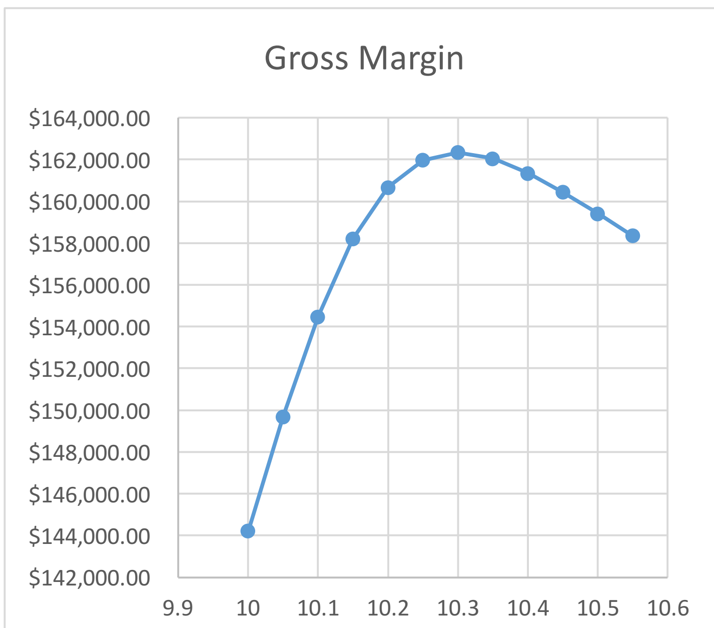


Since the distribution above is approximately normal (right skewed), it is assumed that the bottles, produced in the long run, are normally distributed. Thus, the mean of the fill target keeps changing, which changes the profit made per batch, and the standard deviation is assumed to be 0.16 oz as derived from the sample fill results (calculations shown in the excel sheet). Since the bottles produced are assumed to be normally distributed for every target fill, it is possible to find out the percentage of bottles likely to be under 10 oz. by calculating the z-score with respect to the fill target level. This is done using the NORMDIST function in Excel.

Implicitly, Excel uses the z-score formula $z = \frac{\bar{x}-\mu}{\sigma}$, where $\bar{x}$ = 10 oz., μ = fill-level and σ = 0.16 oz., and calculates the probability. As an example, for a fill-level if 10.2 oz. ($\mu = 10.2$), the corresponding z value is -1.25. The probability of this z value, found using the z table, is 0.3944. As a result, the probability of finding the defect is the area under the normal curve between 0.5000 and 0.3944, which is 0.1056 (10.56%). This information can now be used for calculating the revenue, cost, and profit for a certain batch, with a certain fill level. Choosing different fill levels gives different defects and these defects rates can be analyzed to determine the target level at which the 10 oz. bottles of Linatol should be filled, in order to achieve maximum profit.

Profit is used as a measure to decide the recommended target level. Profit depends on the revenue from the commercial and secondary markets, the cost of ingredients, blending costs and the cost of labor for both commercial and secondary markets. The profit is calculated by batch (5000 liters), and thus specifically the active ingredients cost, blending direct/indirect labor and the blending overhead costs remain the same. However, depending on the fill target, the filling cost and the secondary packaging will be different because these measures are based on the *seconds* which change for every fill-target. A table and a chart showing the Gross Margins at different fill targets for standard deviation of 0.16 oz is show below:

Fill Target	Gross Margin
10	$144,222
10.05	$149,676
10.1	$154,478
10.15	$158,200
10.2	$160,674
10.25	$161,975
10.3	$162,337
10.35	$162,043
10.4	$161,346
10.45	$160,431
10.5	$159,414
10.55	$158,357



From the table above, it is seen that the **Gross Margin (Profit) is maximum for a fill target of 10.30 oz. ($162,337)**. With a target fill level of 10.3 oz., there are a total of 1368 cases generated out of which only 3% are rejects (labelled as *seconds*). Even though the number of rejects will be lower for a greater target fill, the filling cost (labor, materials and overhead) and the re-packaging cost are the lowest when compared to the revenue of the cases for this target level, and thus the profit is the highest for 10.3 oz. The operating profit statement for Linatol for a fill target of 10.30 oz. is shown below:

Fill Target	**10.3 oz**
No. of Cases	1368.02589
Standard deviation	0.16 oz.
Defective Rate for Fill Target	0.030396362
Commercial Markets	1326.44288
Seconds	41.58300986
Item	**Cost**
Revenue:	
Commercial	$246718.3757
Seconds (3% rejects)	$6187.551867
Total	$252905.9276
Costs:	
Active Ingredients	$67,662
Blending direct labor	$432
Blending indirect labor	$170
Blending overhead	$1698
Filling Material	$18057.94175
Filling direct labor	$560.3434045
Filling overhead	$1959.013074
Seconds packaging labor	$29.45463198
Total	$90,569
Gross Margin (Profit)	**$162,337**

iii. Conclusion

Assuming that the bottles produced in long run for a target level are normally distributed, for a batch of 5000L, the fill target of 10.3 oz. gives the maximum profit ($162,337). This profit depends on the number of commercial and second cases generated, the filling costs (materials, labor & overhead) of the cases and the re-packaging costs for the seconds. In order to calculate this profit, different fill target levels were tested using the z score of the normal distribution to determine the percentage of defective cases (seconds), the expected revenue, costs and profits. After comparing the profits for each of these levels, the level with the highest profit was chosen. Thus as a recommendation, the target amount to which each of the 10 oz. bottle of Linatol should be filled is 10.3 oz to ensure the highest profit. Detailed calculation for all of the above values can be found attached in the Excel sheet.

**** Check the Excel sheet for detailed calculations of the above report.**