# Is Medworld Cheating? Part 1[[1]](#footnote-1)

Medworld is a reputed a drug manufacturing company and one of its main products is Slezx, a life-saving drug. At the time of obtaining the license from Drug Regulatory Authority (DRA), this 500mg tablet was slated to contain 100 mg of the ‘medicine’ and 400 mg of ‘filler’; the variance of ‘medicine’ in the tablets was also slated to be 12.25 sq.mg. Recently a complaint has been registered at the DRA claiming that Medworld is giving more fillers than stipulated on average.

In order to validate the charge, DRA appoints a senior inspector, Rama. Rama has decided to check the content of 50 randomly sampled Slezx tablets from the market and measure the medicine content of these tablets. Rama as well as the people who brought the charge against Medworld believes that there is no problem with quality control at Medworld and hence there is no reason to question Medworld’s stated position on variability in the medicine/filler content or the total weight of the Slezx tablets. Before carrying out the test, Rama wants to announce her procedure to both the parties.

The following is a list of issues Rama prepared that she believes would help addressing the problem objectively.

1. What stand should Rama take prima-facie, before checking the tablet contents? Does it make any difference?

2. Should she address the problem from the requirement perspective of filler content? Or medicine content? Does it make any difference?

3. Can she afford to presume that Medworld is innocent till proven guilty?

4. On what minimum numerical evidence should she take action against Medworld?

5. What are the possible errors that she can possibly make while taking her decisions? What are the likelihoods of the same?

6. How much improvement can she expect in her decision making if she decides to double the sample size?

What should be her decision?

Her sample of 50 tablets produced the following amounts (mg) of medicine contents.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 99.85 | 96.33 | 107.2 | 96.81 | 100.32 | 99.45 | 95.81 | 97.2 | 96.82 | 101.57 |
| 98.53 | 97.19 | 96.53 | 103.2 | 95.68 | 97.78 | 106.87 | 104.58 | 101.95 | 103.81 |
| 98.43 | 93.06 | 103.69 | 94.98 | 103.26 | 97.63 | 97.09 | 96.85 | 93.36 | 100.08 |
| 98.73 | 102.26 | 103.28 | 97.47 | 99.25 | 99.63 | 98.26 | 102.25 | 100.86 | 98.92 |
| 95.5 | 100.15 | 99.77 | 101.13 | 97.83 | 98.24 | 98.23 | 98.27 | 100.76 | 100.01 |

**Is Medworld Cheating? Part 2**

How many tablets Rama ought to sample if she wants to estimate the actual filler content within 0.5 gm of the true value with 95% confidence?

|  |  |
| --- | --- |
| Desired DMOE | 0.5 |
| Minimum sample for desired MOE | 189 |

**Is Medworld Cheating? Part 3**

Refer to Part 1 of the case. How many tablets Rama ought to sample if she wants to limit the following risks at the level stated below:

• **If Medworld is cheating by 1 mg on average, then there ought to be at least 98% chance in the adopted procedure that Rama is able to catch Medworld’s wrong-doing;**

Here in hypothesis test we are operating in the column:

|  |  |  |
| --- | --- | --- |
|  | **Population mean actually 100 mg** | **Population mean != 100mg** |
| **Conclude population mean = 100 mg** |  | Type 2 error. Probability of commiting = β = 0.02 |
| **Conclude population mean != 100 mg** | Type 1 error. Probability of commiting = α = 0.5 | By 98% Confidence interval I want to operate here |

We will be operating on the curve for means = 99mg and 101 mg. For sample size = 50, the β = 0.52 at the given means. We need to increase the sample size so that β comes down to 0.02.

• If Medworld not cheating then should be no more than 1% chance that it is penalized by mistake.

Here we are operating in this region.

|  |  |  |
| --- | --- | --- |
|  | **Population mean actually 100 mg** | **Population mean != 100mg** |
| **Conclude population mean = 100 mg** |  | Type 2 error. Probability of commiting = β |
| **Conclude population mean != 100 mg** | Type 1 error. Probability of commiting = α = 0.5 |  |

**Is Medworld Cheating? Part 4**

Rama decided that she would first check whether the average medicine content is as specified. But subsequently she also wants to verify if 50% or more tablets produced has medicine content less than 99% of the printed amount. Would her decision change?

For this we need to estimate population proportion of tablets < 99mg content. Based on our sample below is the result:

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Sample data | | | | | | | | | |
| 99.85 | 96.33 | 107.2 | 96.81 | 100.32 | 99.45 | 95.81 | 97.2 | 96.82 | 101.57 |
| 98.53 | 97.19 | 96.53 | 103.2 | 95.68 | 97.78 | 106.87 | 104.58 | 101.95 | 103.81 |
| 98.43 | 93.06 | 103.69 | 94.98 | 103.26 | 97.63 | 97.09 | 96.85 | 93.36 | 100.08 |
| 98.73 | 102.26 | 103.28 | 97.47 | 99.25 | 99.63 | 98.26 | 102.25 | 100.86 | 98.92 |
| 95.5 | 100.15 | 99.77 | 101.13 | 97.83 | 98.24 | 98.23 | 98.27 | 100.76 | 100.01 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |
| 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |

Here 1 denotes encoding for samples which are < 99 mg and 0 denotes samples >= 99mg

Sample proportion = p = 0.52

Sample proportion std. deviation = Sqrt(p(1-p)/n) = 0.07065

# Queries

Q: For campaign at saree sagar we had seen when we are trying to estimate the population mean of amount of orders with 90% confidence interval it was as below:

**Case 1: When we considered population standard deviation.**

Confidence interval = 0.9; Population standard deviation = 4608; Number of samples = 144

In Normal distribution the lower limit of order is ₹5908.38 and higher limit of order is ₹7171.62

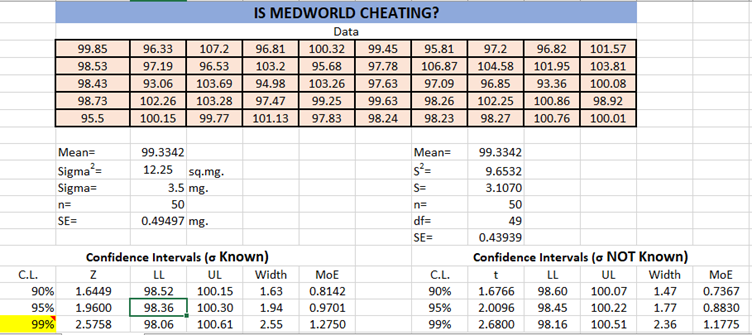
**Case 2: When we tried estimating from a given sample standard deviation of ₹4803**

Confidence interval = 0.9; Sample standard deviation = 4803; Number of samples = 144

In t distribution the lower limit of order is ₹5877.35 and higher limit of order is ₹7202.65

We saw that with the same confidence interval the Margin of Error is higher in case of t-distribution and lower in case of normal distribution which goes by the graphical nature of the curves (Normal and t-distribution) that as there is more uncertainty associated with t-distribution it is taken care by the increase in margin of error by what was termed as **playing it safer** by professor.

While in the case of Is Medworld cheating we got a higher margin of error in case of normal distribution and lower in case of t-distributions as below if we consider “slated” population standard deviation as 3.5 mg.



Questions:

1. Why in the case of Medworld is the understanding of contradicting once we took into consideration population standard deviation? Can we draw an inference from this contradicting idea that in this case considering population standard deviation might not be a good idea for estimation? If no what inference can be drawn with this contradiction?
2. Practically speaking particularly in similar case of MedWorld the problem statement says 500mg tablet was **slated** to contain 100 mg of the ‘medicine’ and 400 mg of ‘filler’. Variance of ‘medicine’ in the tablets was also **slated** to be 12.25 sq.mg .Is it proper to estimate population mean by considering the “slated” numbers to be actual truth? So will it be more proper to go for t-distribution than Z-distribution in this use case?

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