Process capability

Related to Subway system operations improvement and terrorism prevention

Group members:
Borui He
Jainil Himanshub Jani
Sohel Nasirhussain Jiwani
Rakesh Kachariya
Yu Long

Homework

Requirements

This is a process capability analysis for Improvements on a System after three different efforts. Specs are LSL=83 and USL=107, respectively. Assess the performance of the process **before** improvements are made. **After** three different **improvements** (that respectively affected the mean, spread and both of these simultaneously) the performance of the process is again reassessed.

Analyze the Capability of the process **before**, and individually **after** each of the three improvements were implemented. Analyze each result, separately. Finally, select the improvement that you feel that better resolves the situation, even if not completely. Write a short but substantiated Report to your manager, that discusses:

1. All the analyses done and their results
2. All the model assumption checks that you performed
3. Your conclusions regarding which course of action to take
4. And what you think your organization should do next.

DESCRIPTIVE STATISTICS

Before means the data of the system before any improvement.

Sig refers to standard deviation.
AfterSig means the statistics after modifying std deviation.

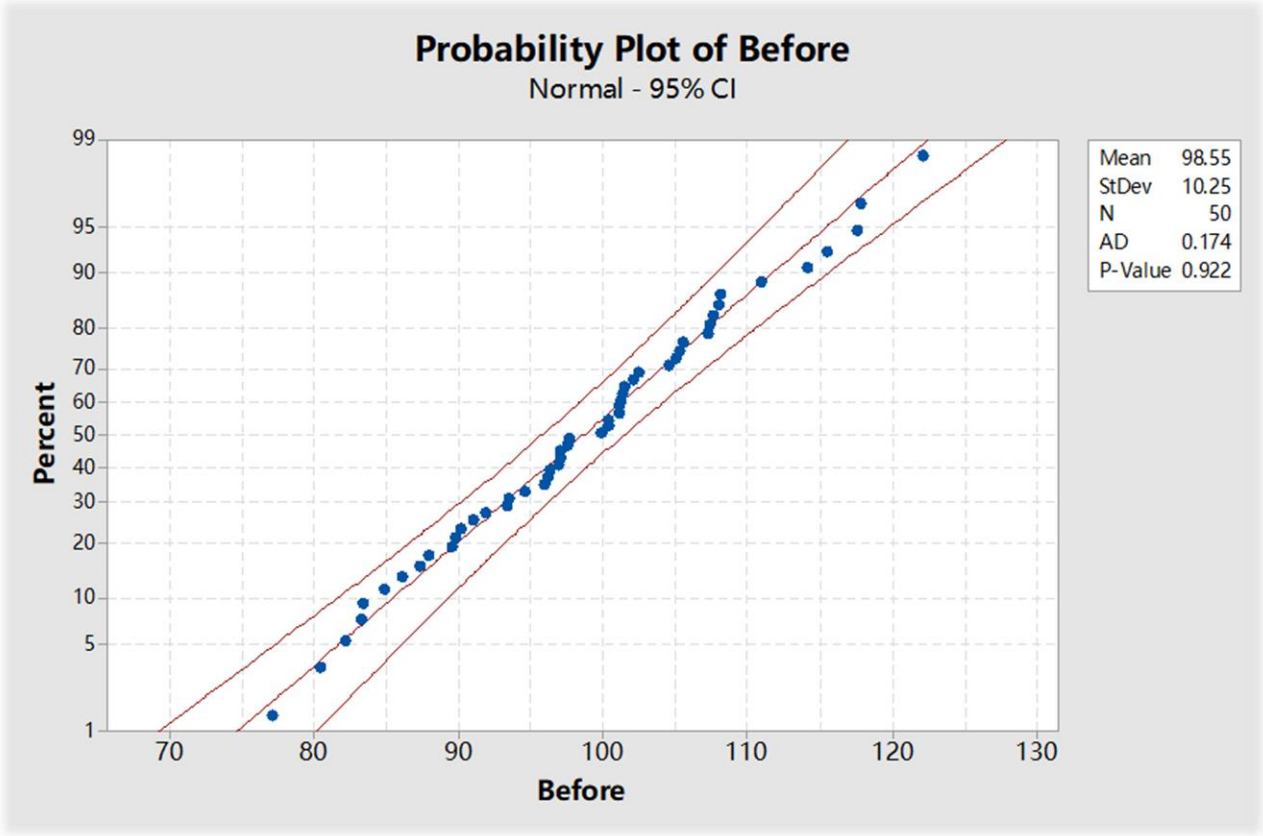
Mu refers to mean.
AfterMu means the statistics after modifying mean.

BothS&M means the statistics after modifying both mean and std deviation.

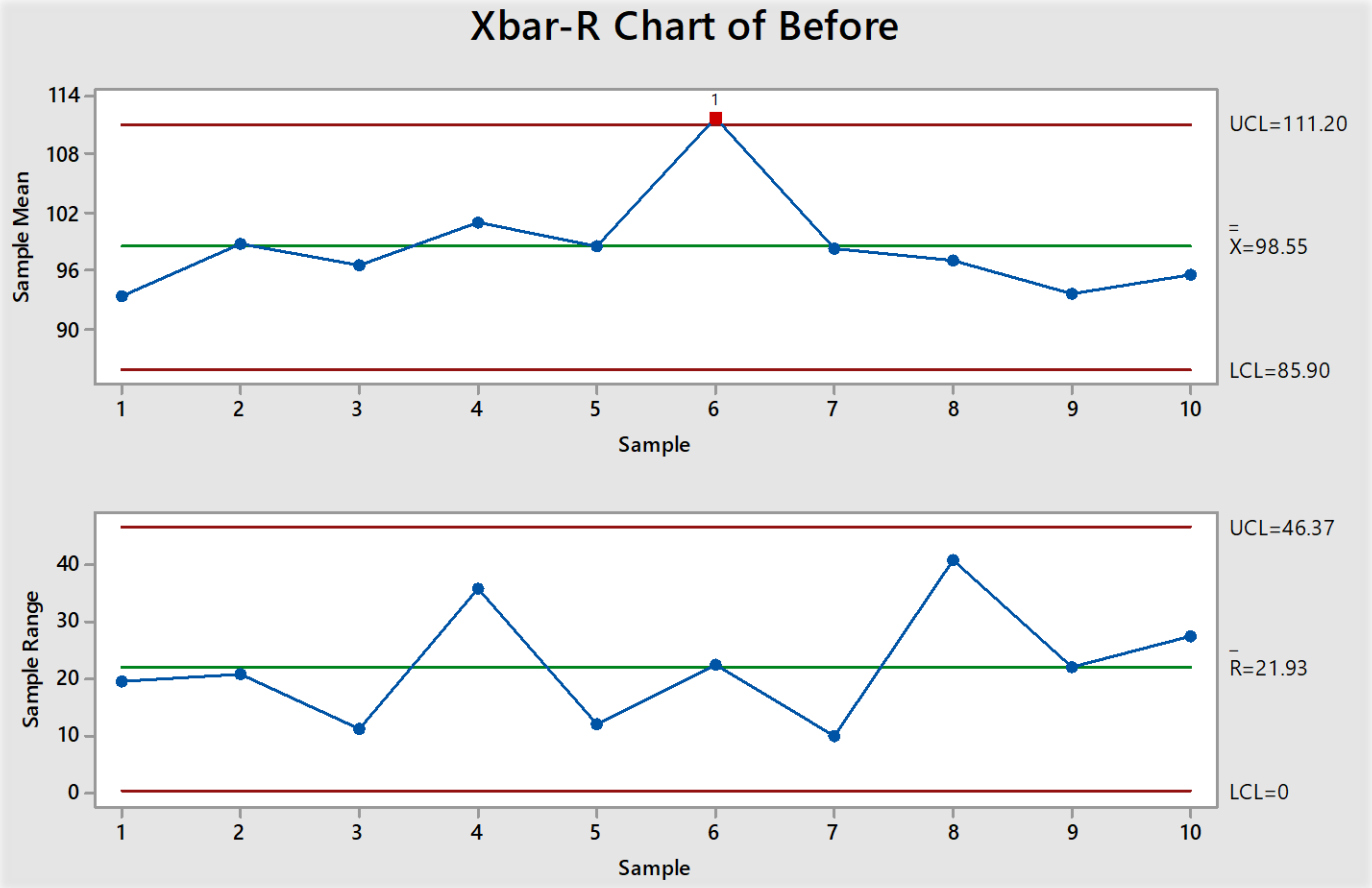
Preparation.

Firstly, we need to identify whether the process is stable and follows a normal distribution so we draw the control graph using the MINITAB.

All following analysis is based on a normal distribution. That’s the reason why we have to check its P-value before any analysis.



It shows the P-value is 0.922 which is much greater than the significance level of 0.05.So decision is to fail to reject the null hypothesis, that is, data follow a normal distribution.



According to the graph, we can know that there is one point beyond the control line, so we cannot determine the process always keep the stable.

Something has been done through MINITAB but you may not realize before

Secondly, we start making the process capability analysis. We estimate the std deviation of the population (σ) through the std deviation of the sample (s).

$$s = \sqrt{\frac{\sum (x_i - u)^2}{n - 1}}$$

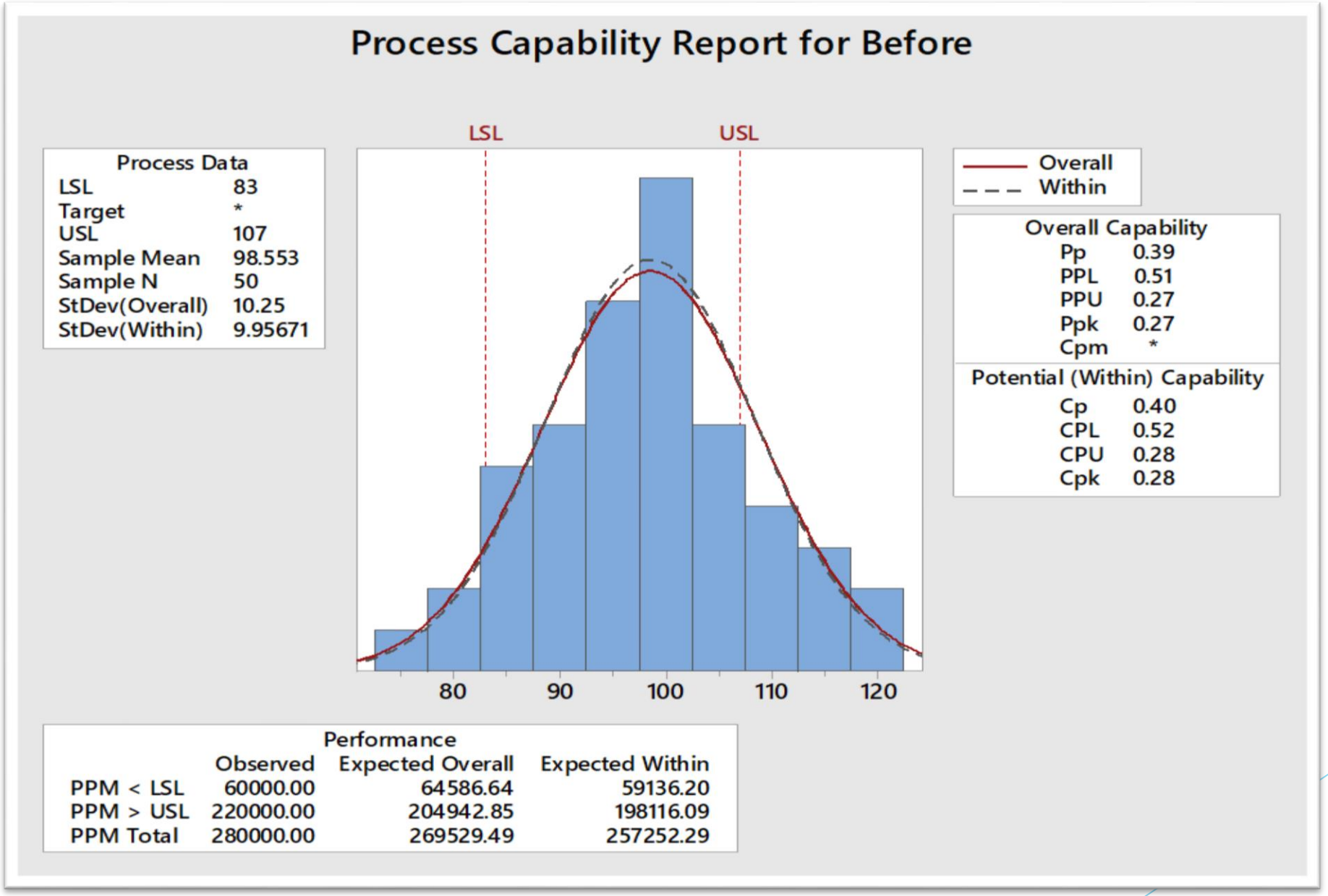
u is the mean of all data.

If there is no point beyond the control line, we can determine the process always keep the stable. Thus we use

$$\sigma = \frac{R}{d2}$$

as our standard deviation.
R is the mean of the range of tolerance of all subgroups.
d2 is determined by number of subgroup, it can be looked by table.

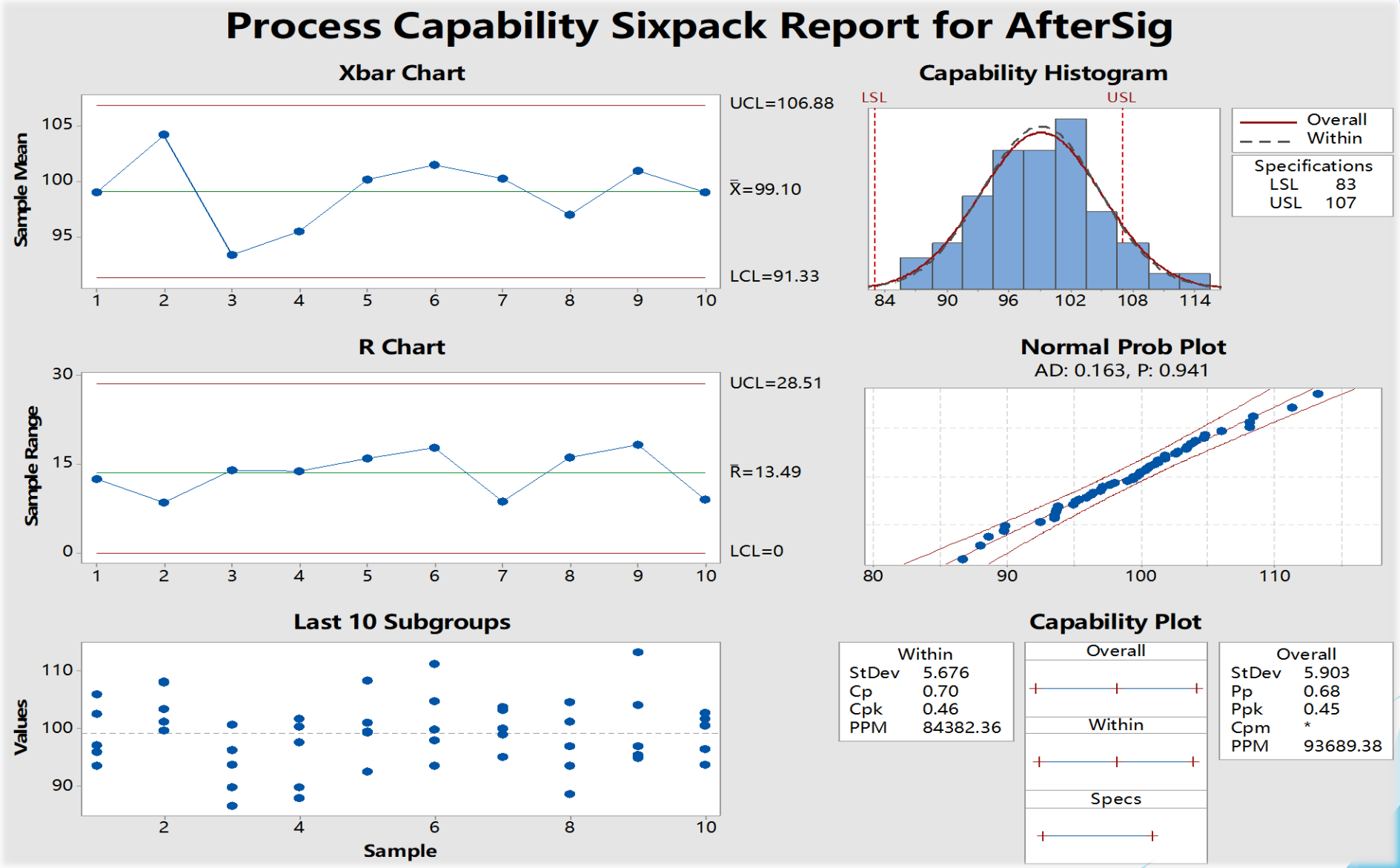
ANALYSIS OF DATA.(process capability)



1. According to the graph that, we can know that the Cp=0.4,Cpk=0.25,both of them are consider cannot be accepted. The process capability should be improvement.
2. There is difference between Cp and Cpk illustrates that the mean of the population is not same as the mean of tolerance of mean.

There are three scenarios below in order to get higher CP and Cpk:

Plan A: Improving standard deviation

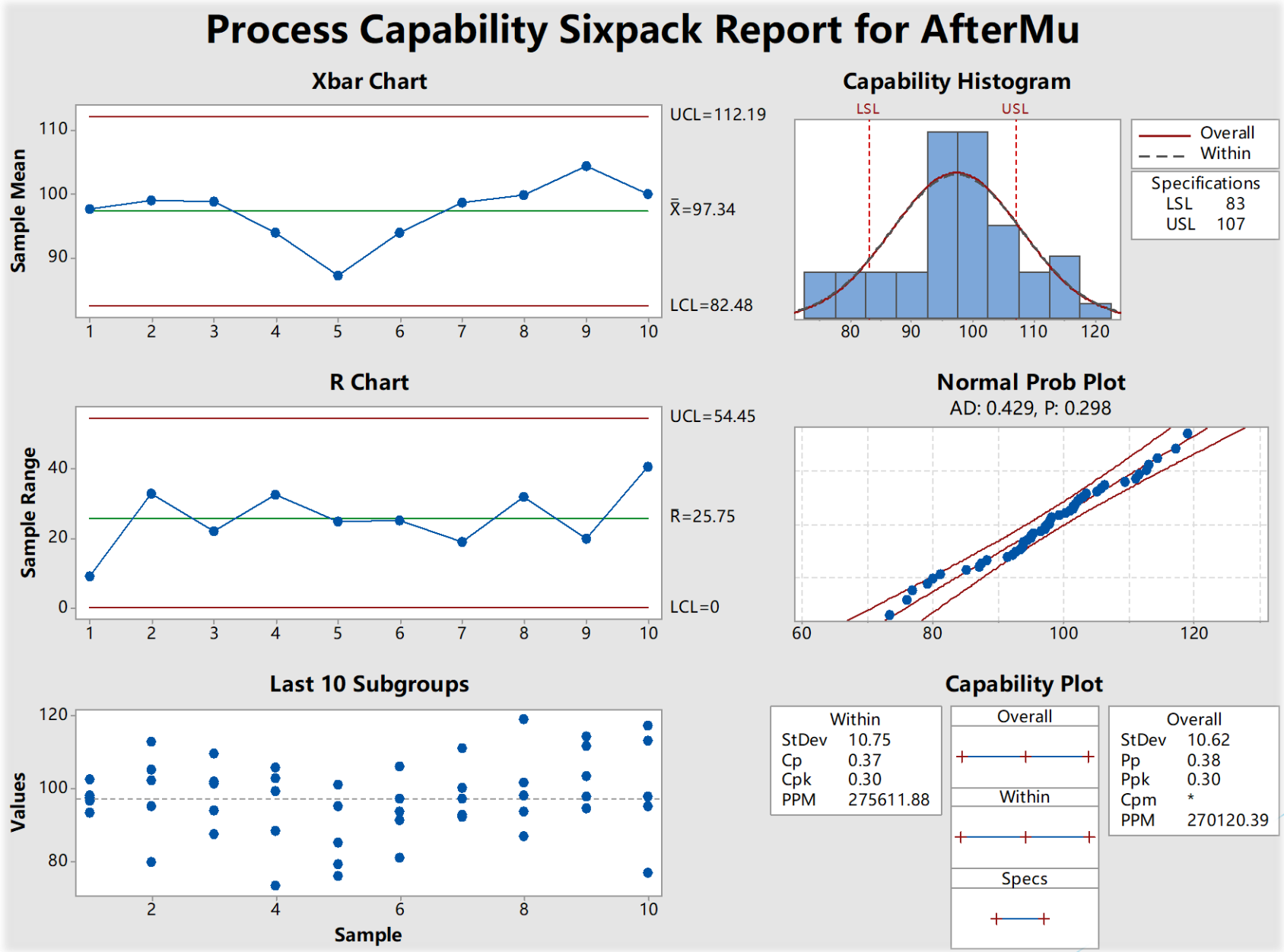


1. According to the graph that, we can know that the Cp=0.7,Cpk=0.46,both of them are consider cannot be accepted. The process capability should be improvement.

2. There is difference between Cp and Cpk illustrates that the mean of the population is not same as the mean of tolerance of mean.

3. From Xbar-R chart we could know there is no point beyond the tolerance lines. There is no need to estimate standard deviation of population(σ) through the std deviation of the sample (s).

Plan B: Improving mean

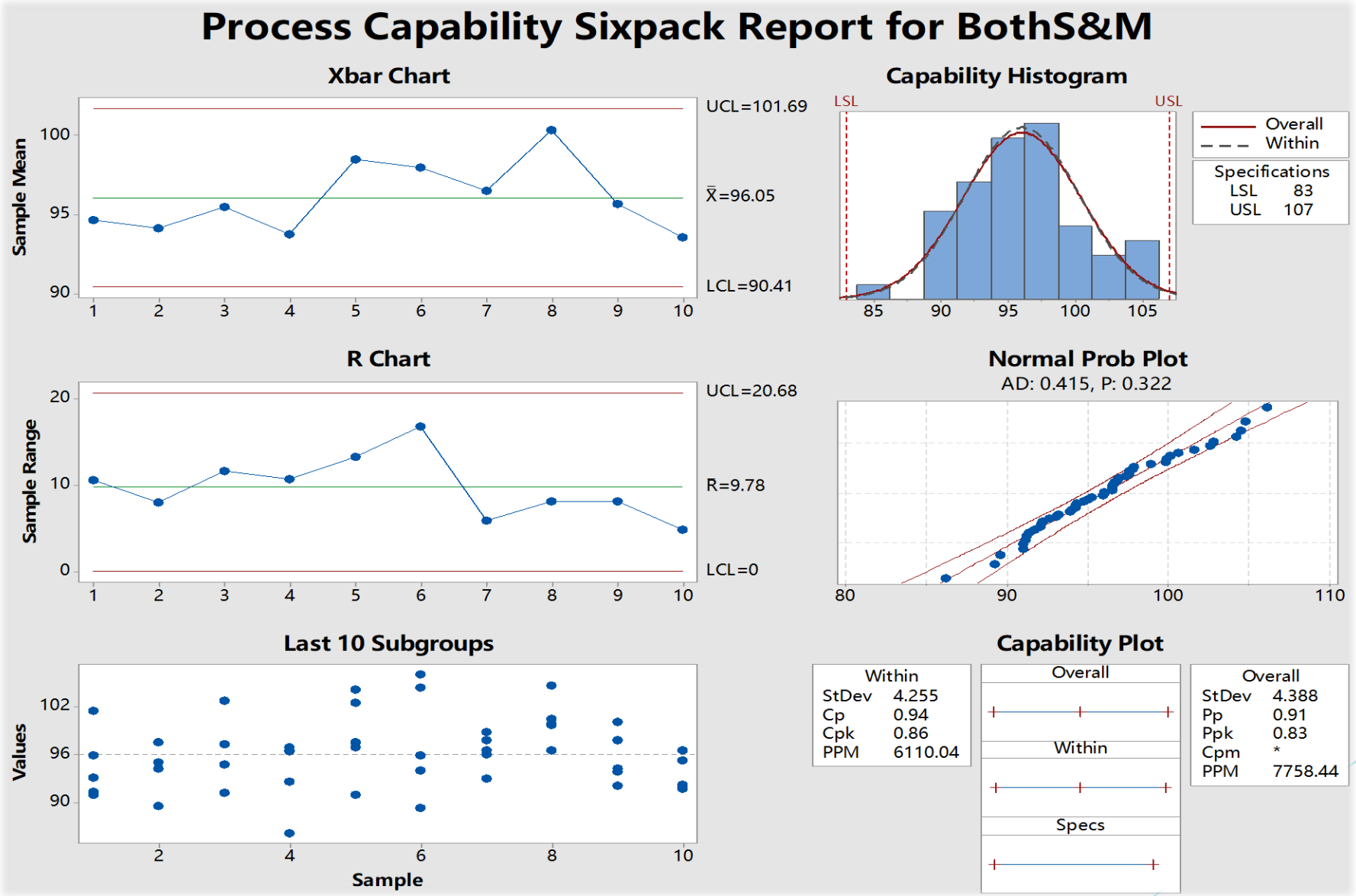


1. According to the graph that, we can know that the Cp=0.37,Cpk=0.30,which is even lower than the result of only improving standard deviation. The process capability should be improvement.

2. From Xbar-R chart we could know there is no point beyond the tolerance lines. There is no need to estimate standard deviation of population(σ) through the std deviation of the sample (s)

3. Sample mean become more stable than improving std deviation but sample range has an opposite result.

Plan C: Improving both standard deviation and mean



1. According to the graph that, we can know that the Cp=0.94, Cpk=0.86, which has the best effect among three scenarios. But We generally want a *C*pk of at least 1.33 [4 sigma] or higher to satisfy most customers.

2. From Xbar-R chart we could know there is no point beyond the tolerance lines. There is no need to estimate standard deviation of population(σ) through the std deviation of the sample (s).

3. Sample range has become much smaller than before

conclusion

There is no doubt that should take the last scenario as the solution to this process capability analysis if we have to choose one. Both improve standard deviation and mean will be improved. But it isn’t the final conclusion yet.

It is vital to consider how much it will cost for this improvement as an organization leader because improving standard deviation usually means more precise equipment, experienced workers, better material and probably precipitating more downgrading at the beginning. In this case I suggest investing in improving standard deviation and mean without any doubt. There exists nearly 3 percent deviation of mean which could be solved by making new benchmarks immediately. The manager should intensely focus on standard deviation. Original data indicates its range is as much as 21.93 before any improvement and after our scenario it decreases to 9.78. Standard deviation range decreases to half of its original value means improving standard deviation helps this system a lot.

Considering getting a low value of Cpk even after improvingS&M, the organization would better give up this existing process and redesign it directly.

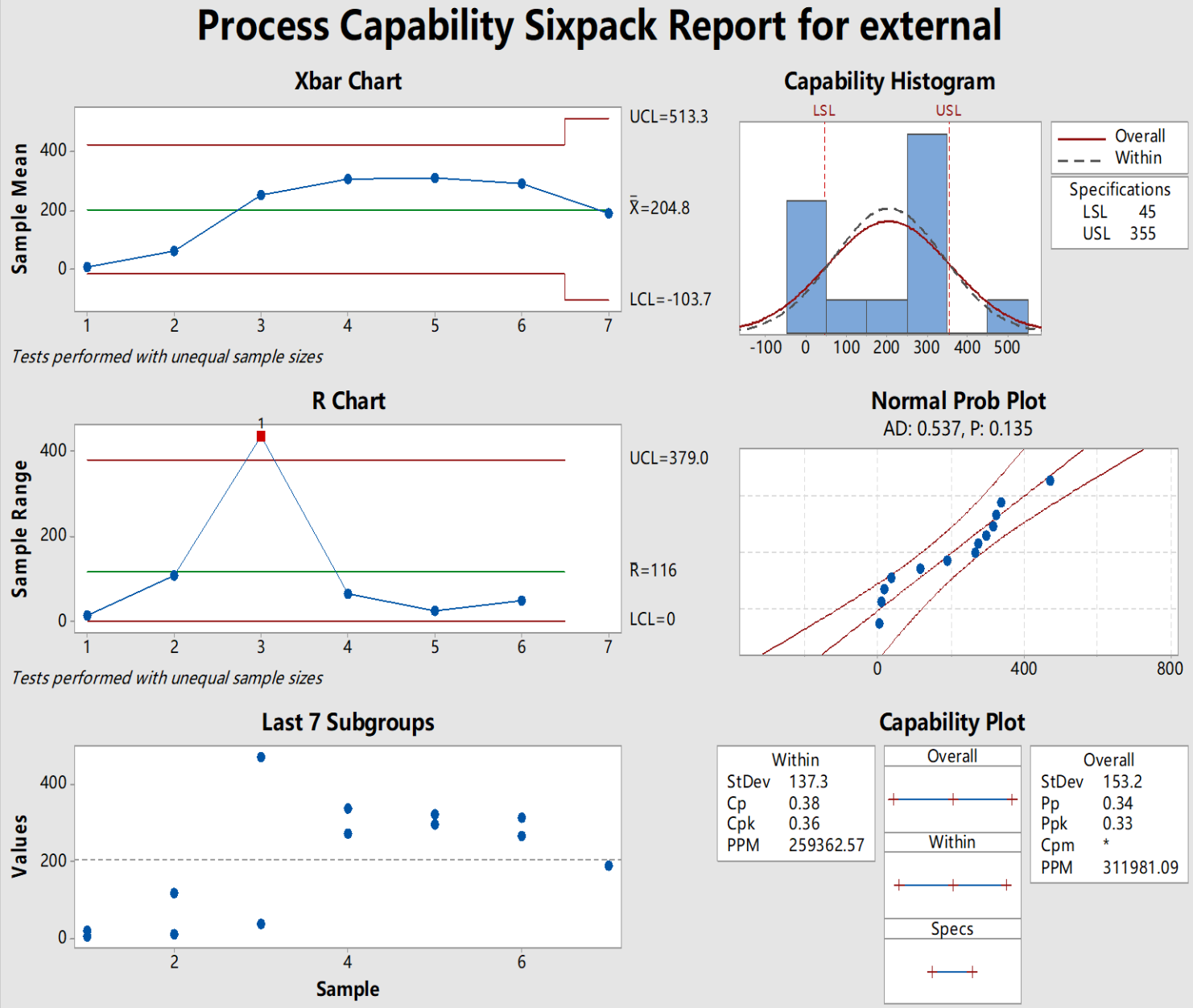
Final project

Train On-Time Performance

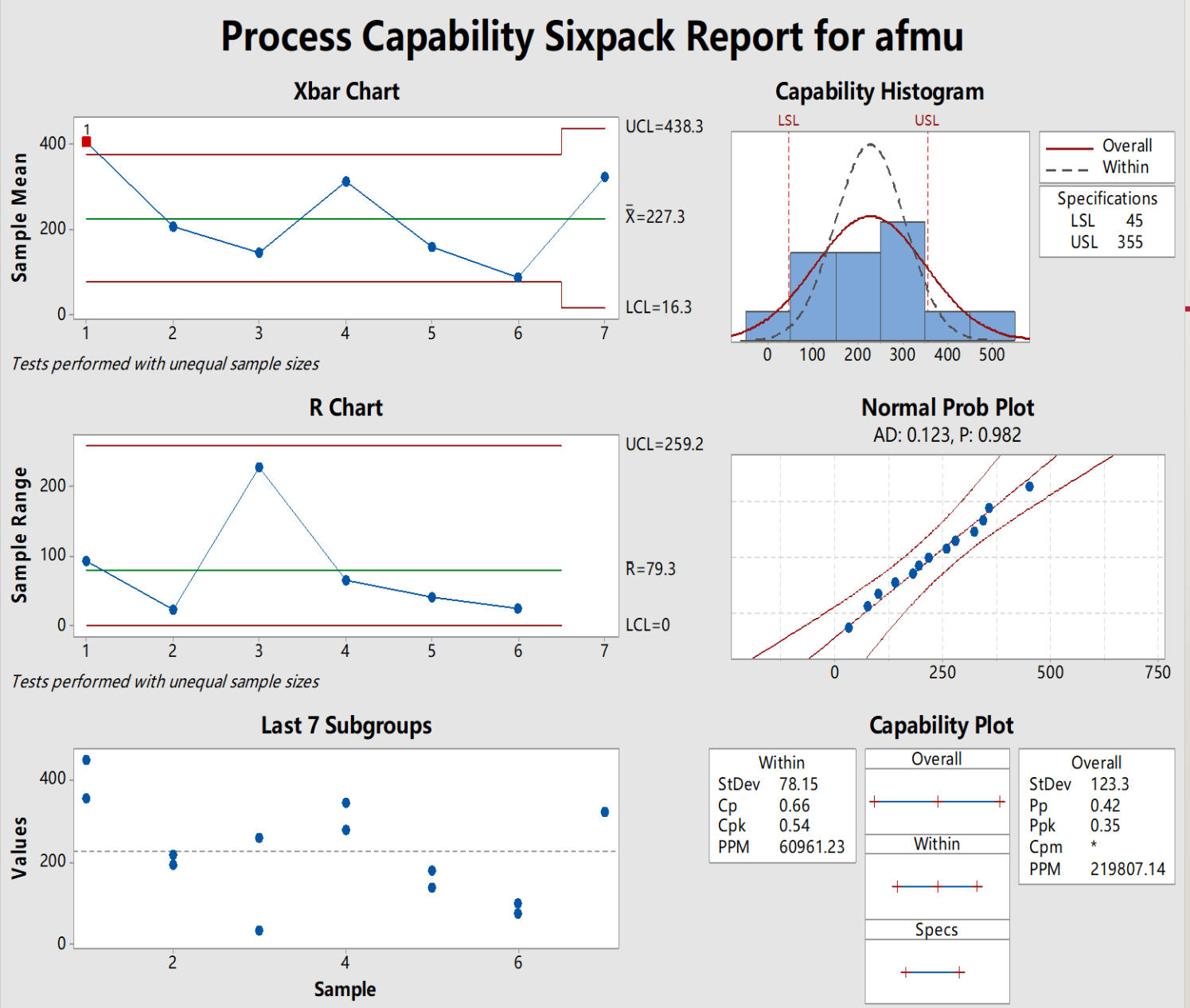
Metropolitan Transportation Authority: New York City Transit

Delays by Category
(Weekday and Weekend)

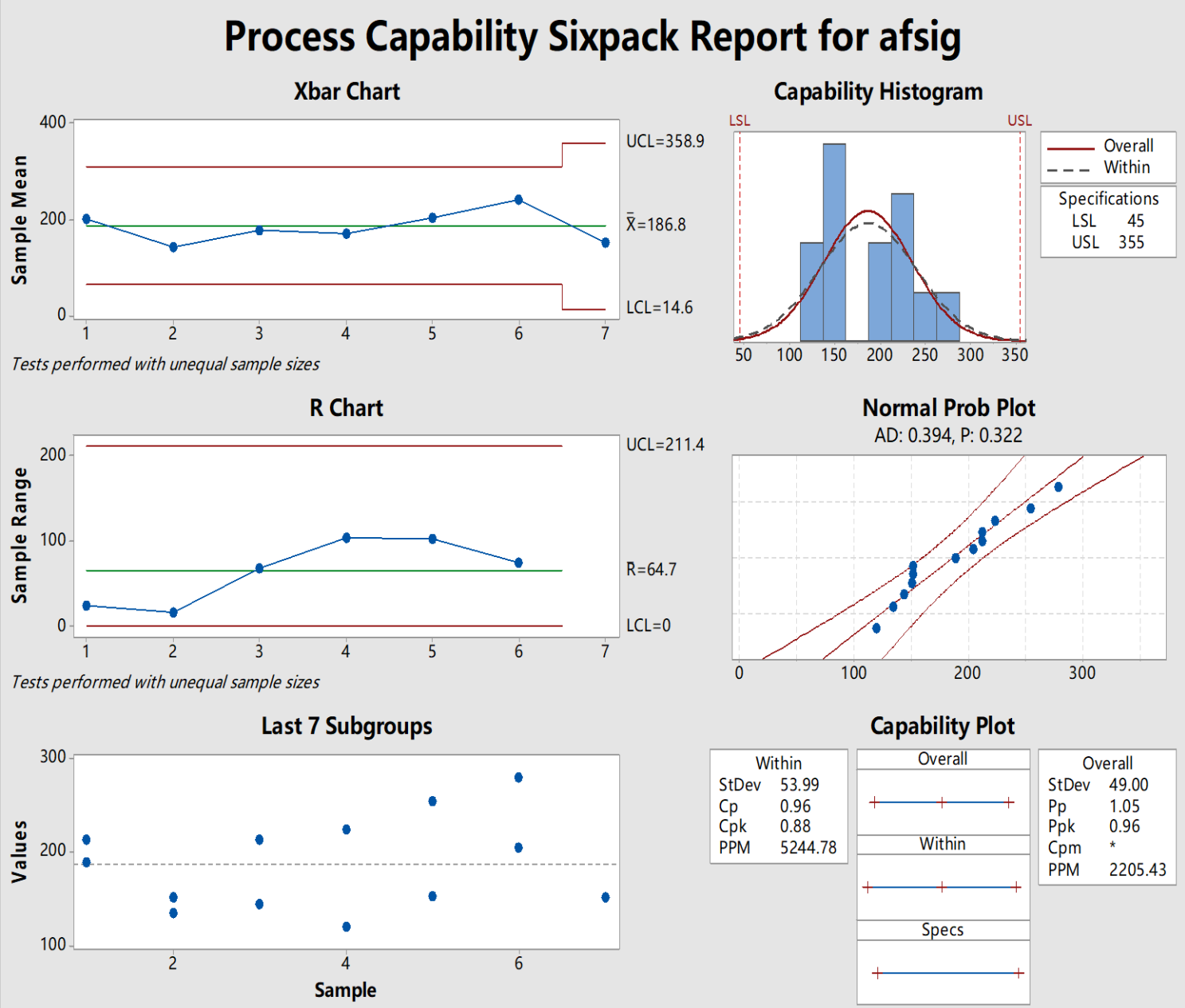
Categories	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Total
Car Equipment	1,527	1,967	1,222	1,729	1,381	1,899	2,409	2,735	2,457	2,020	2,095	2,578	3,638	27,657
Collision/ Derailment	0	0	0	41	263	0	0	5	3	0	0	0	0	312
Employee	509	545	616	673	683	1,059	1,095	1,248	785	746	481	731	882	10,053
External	5	18	9	117	37	472	274	338	297	323	266	316	190	2,662
Fire	334	817	763	564	1,034	453	986	299	927	585	1,224	936	864	9,786
Inclement Weather	537	1,759	500	87	274	494	63	63	36	68	320	2,156	7,020	13,377
Infrastructure	408	1,120	792	212	295	537	313	1,115	263	397	85	590	1,235	7,362
Operational Divisions	269	240	267	299	406	306	304	262	363	443	630	757	905	5,451
Over Crowding	5,050	5,759	5,023	5,029	5,090	5,384	5,892	5,823	6,374	7,225	7,419	7,883	8,665	80,616
Police	2,187	2,046	2,343	2,430	1,873	1,668	1,738	1,514	1,595	3,571	1,998	2,247	2,381	27,591
ROW Delays	9,325	7,896	6,668	6,365	9,064	8,617	11,857	9,580	9,766	8,678	10,204	11,287	14,362	123,669
Sick Customer	2,548	2,196	2,617	2,374	2,695	2,373	2,283	2,041	2,500	2,455	2,785	3,066	2,935	32,868
Track Gangs	6,258	6,596	7,767	7,498	8,728	9,372	8,844	9,126	9,055	9,946	8,142	8,302	7,995	107,629
Unruly Customer	1,090	1,035	1,209	1,104	1,122	905	1,036	1,184	1,499	1,275	1,694	1,557	1,289	15,999
Work Equipment/ G.O.	1,423	1,664	1,797	1,739	1,878	2,968	2,954	3,730	3,083	3,793	3,631	1,845	3,352	33,857
Total	31,470	33,658	31,593	30,261	34,823	36,507	40,048	39,063	39,003	41,525	40,974	44,251	55,713	498,889



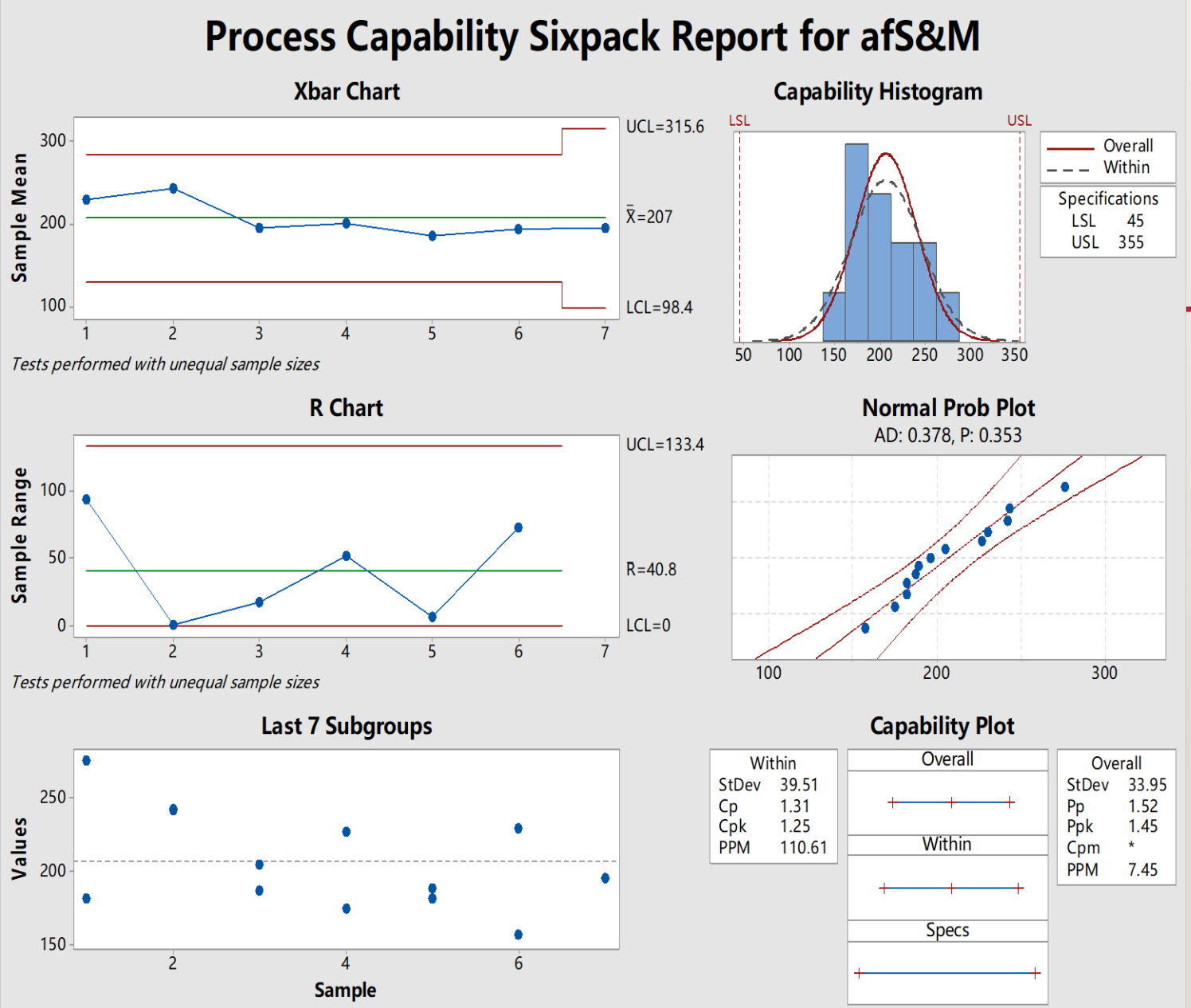
- An unstable process with one point beyond the control line.
- Low Cp and Cpk value which means probably cannot satisfy customers, in this case they are passengers.



- The within line on capability histogram indicates much fewer cases will go beyond passengers' requirement.
- But the low Cp and Cpk value aren't improved significantly. This scenario only solve prat of this problem.



- A more stable process with no point beyond the control line.
- But the low Cp and Cpk value are improved significantly though they are still lower than 1.33[4sigma]. Passengers won't be satisfied either.



- The sample range has decreased from 116 to 40.8. Besides no point goes beyond the control line. It will be a stable process.
- Cp and Cpk value are improved significantly though they are still in the interval (1, 1.33). It may not satisfies most passengers but will be a good choice for the subway system manager.

CONCLUSION

- The external factor mainly refers to factors of the operator (e.g. technical breakdowns) or independent factors (e.g. weather conditions, incidents, accidents).
- It's impossible for any department of subway operation system to control the weather to facilitate system operation. Choosing experienced technician for regular examination and a timely accident information for preparing alternative route if possible will help a lot.