Statistical Process Control (SPC) of US Prison System

Group 8

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Context

1.Backgroud

2.Quick Review

3.Introduction

4.Variables Charts

5.Attributes Charts

6.Conclusion

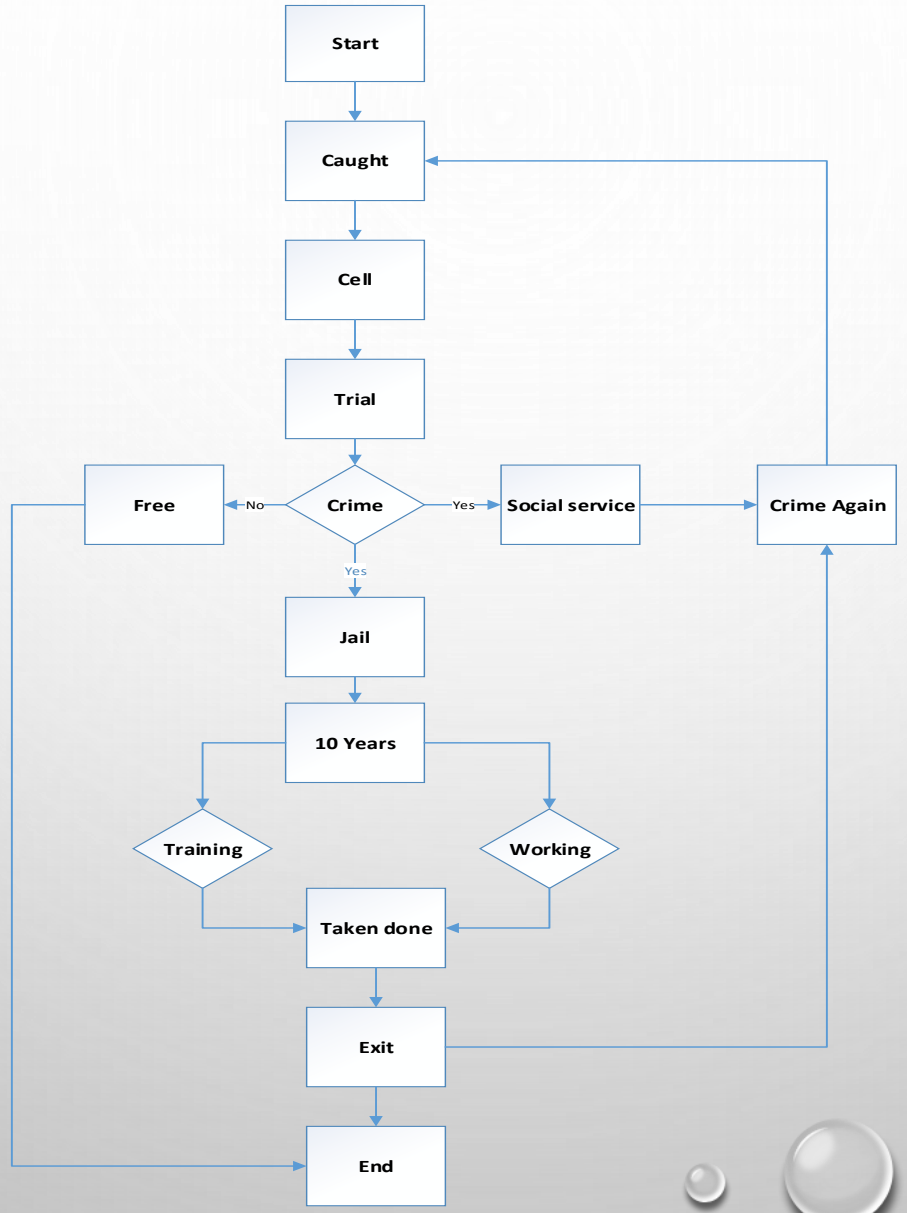
Background

- Number of prisoners is increasing significantly from 2005 to 2014
- One of the reasons is that many prisoners are arrested more than once, and the return rate increases from 8% to 15.7% in the ten years, which is the problem to be solved in our topic
- Too many prisoners and jails may impact the social security and cause financial problems
- Government has to increase the budget to meet the cost of jails
- Statistical Process Control (SPC) will be used in this case

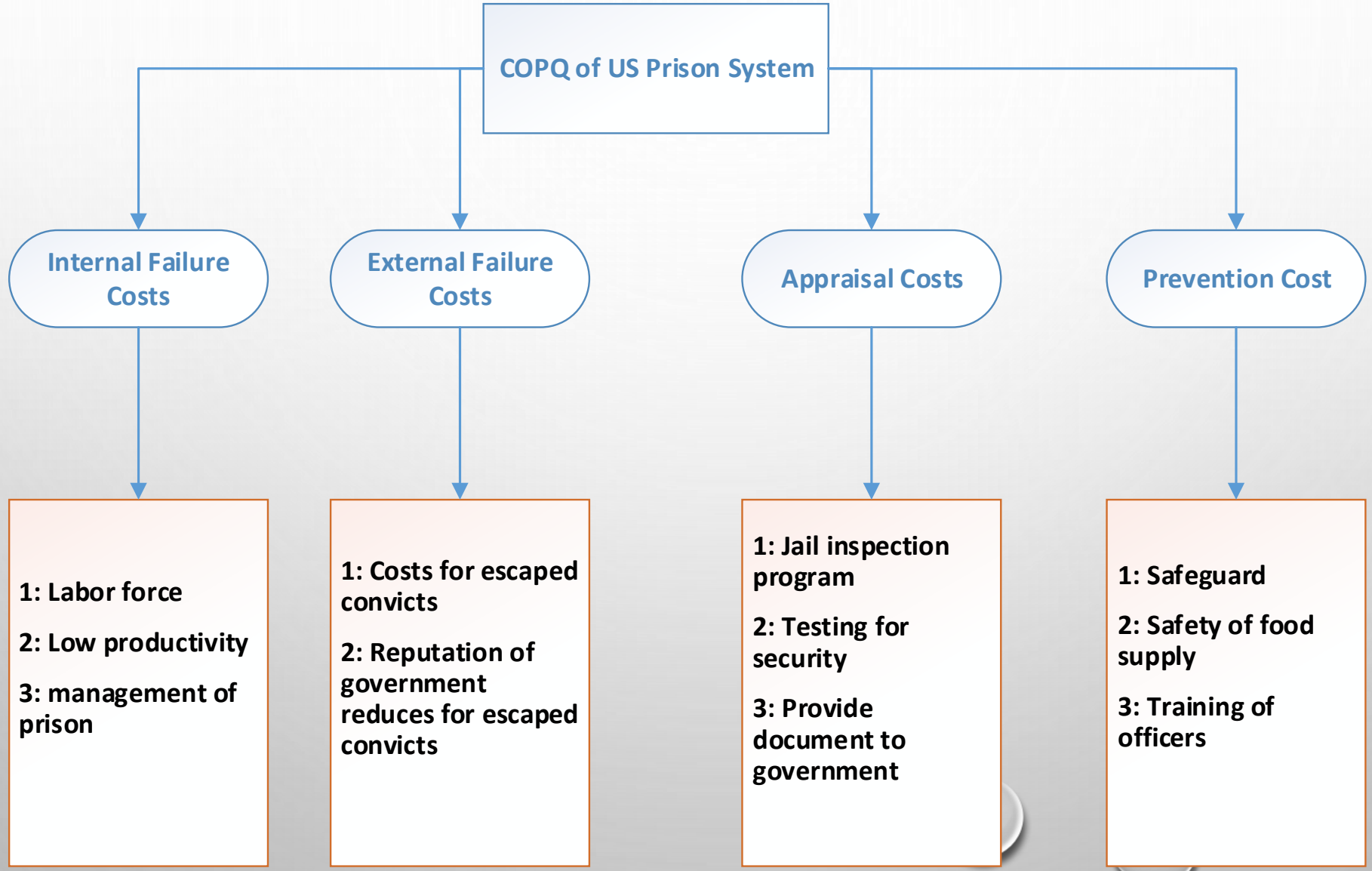
Quick Review

1. Flow Chart
2. COPQ(Cost of Poor Quality)
3. Fishbone
4. House of Quality
5. DOE(Design of Experiment)
6. VSM(Value Stream Mapping)
7. Supply Chain
8. OC Plan
9. FTA(False Tree Analysis)

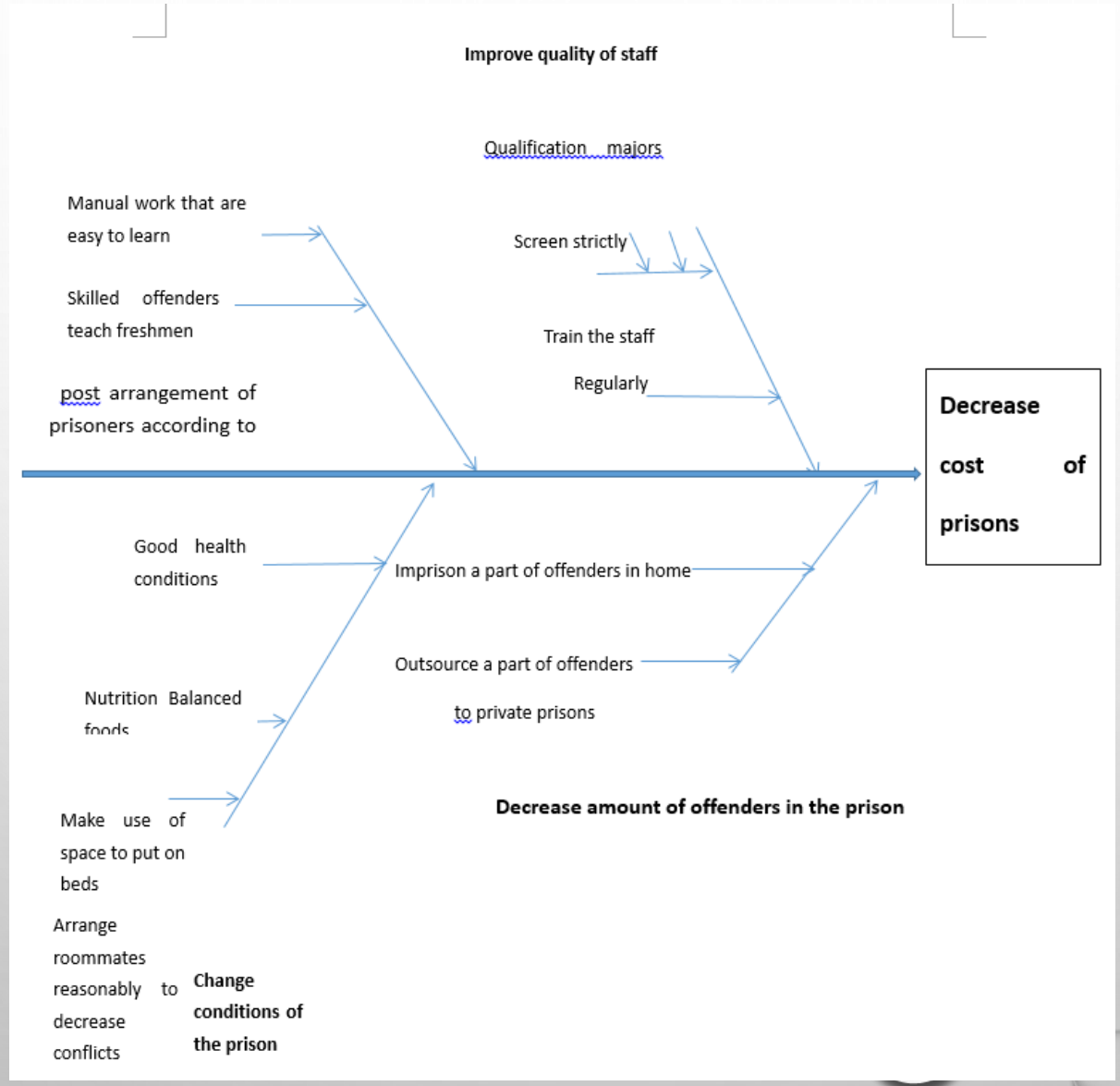
Flow Chart


Start
Caught
Cell
Trial
Crime
No
Free
Yes
Social service
Crime Again
Yes
Jail
10 Years
Training
Working
Taken done
Exit
End

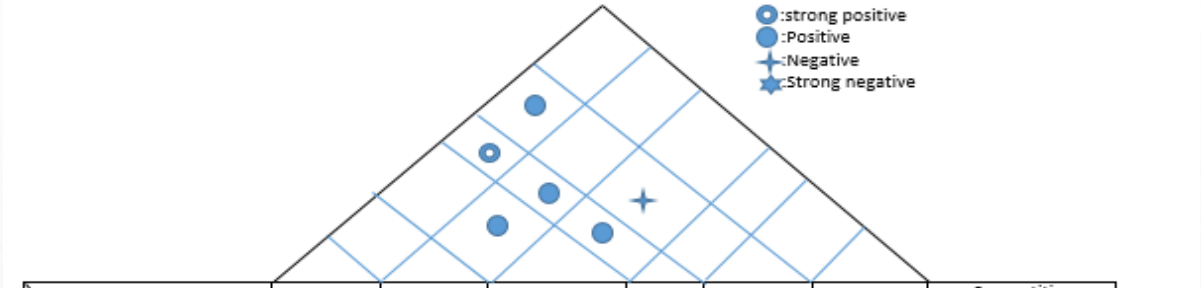
COPQ(Cost of Poor Quality)



Fishbone


Improve quality of staff
Qualification majors
Manual work that are easy to learn
Skilled offenders teach freshmen
post arrangement of prisoners according to
Screen strictly
Train the staff
Regularly
Decrease cost of prisons
Good health conditions
Nutrition Balanced foods
Make use of space to put on beds
Arrange roommates reasonably to decrease conflicts
Change conditions of the prison
Imprison a part of offenders in home
Outsource a part of offenders
to private prisons
Decrease amount of offenders in the prison

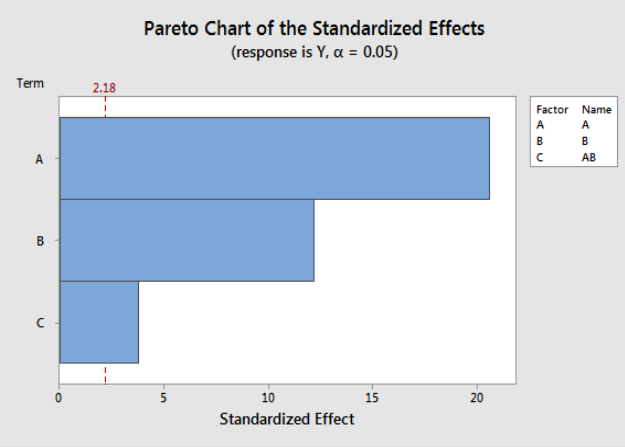
House of Quality

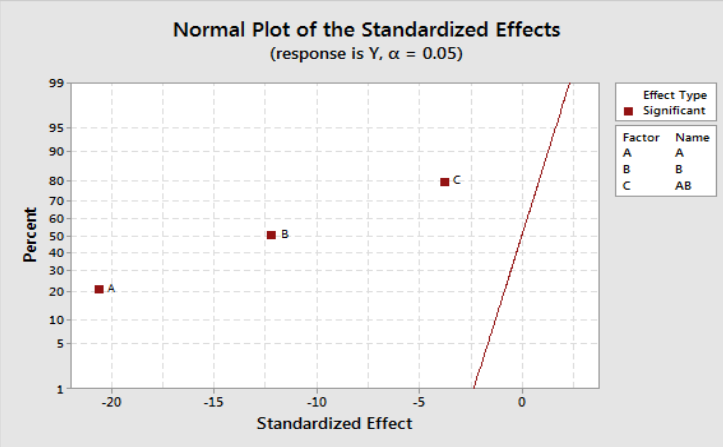


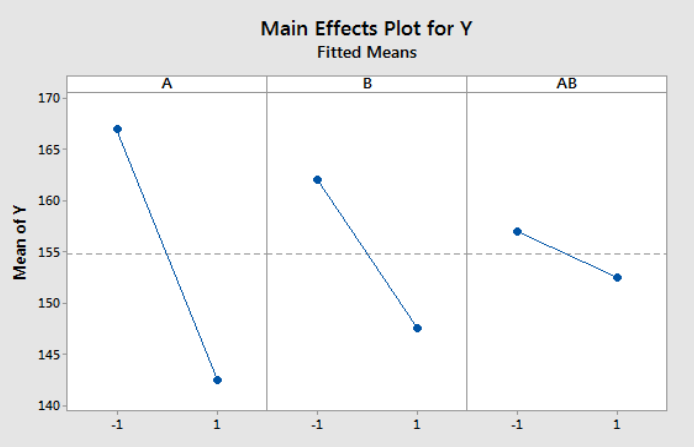
Customer requirement \ Design Requirement		Education	Safeguard	Environment	High-skilled officers	Job for offenders	Importance	Competitive evaluation (X=us, A=Prison A, B=Prison B, 5 is best) 1	2	3	4	5
Offender	Degree of comfort	0	1	9	3	1	3	X		A B		
	Safety	0	9	3	3	0	5		A	X	B	
	Valued	1	0	0	9	1	4			B	A	X
Government	Lower cost	3	9	9	3	9	5				X	A B
	Lower return rate	9	0	1	1	0	3		B		X	A
	Lower break-prison rate	3	9	3	3	3	4	X		A B		
Importance weighting		58	129	102	90	64	/	Relationships: Strong:9 Medium:3 Small:1				
Technical evaluation (5 is best)	5	B X	B		X	B						
	4	A		A X								
	3		X		A	A						
	2			B		X						
	1		A		B							

DOE of 2 factor

run	A	B	AB	Y1	Y2	Y3	Y4	Avg
1	-	-	+	173	172	169	174	172
2	+	-	-	150	154	149	155	152
3	-	+	-	163	159	162	164	162
4	+	+	+	132	133	136	131	133

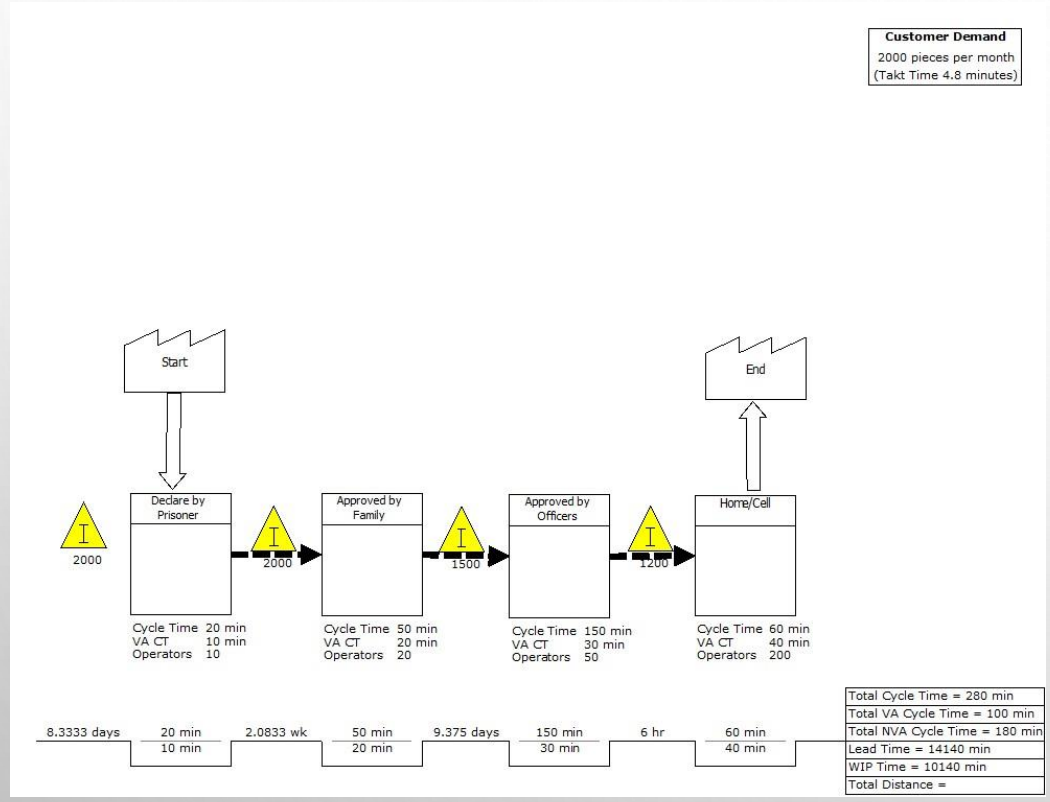




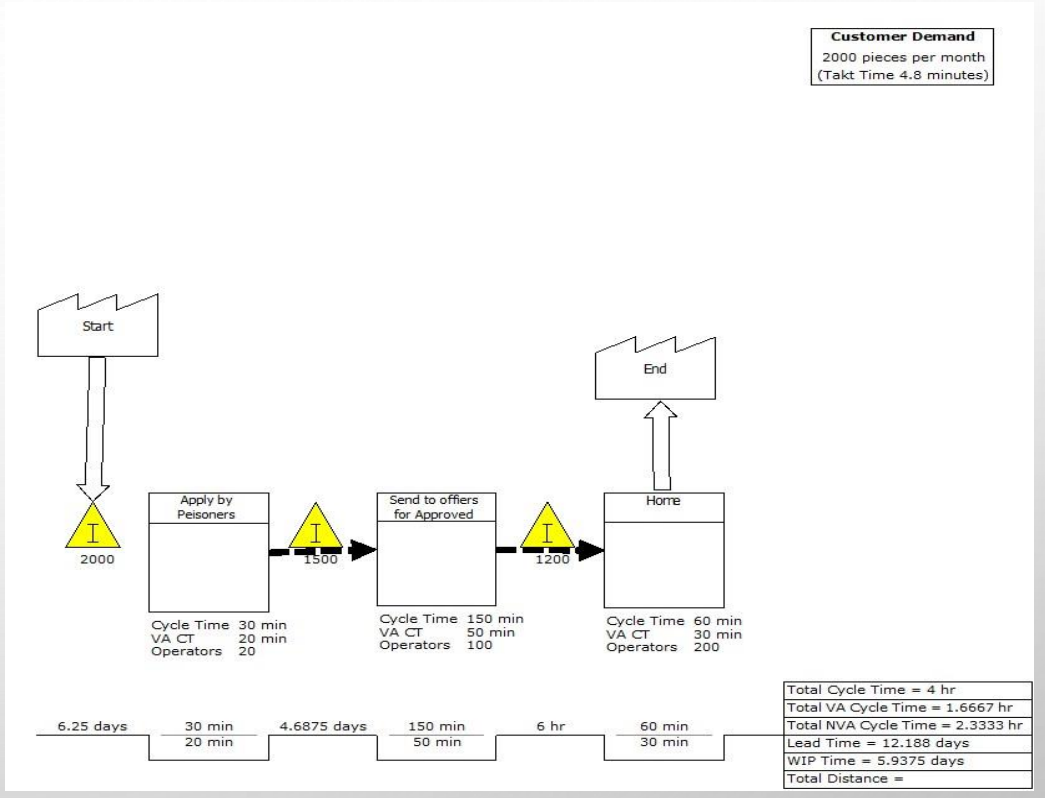


VSM for Lean Manufacturing

Current

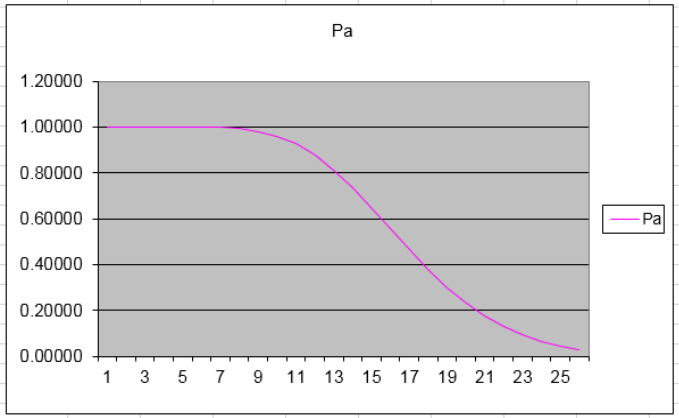


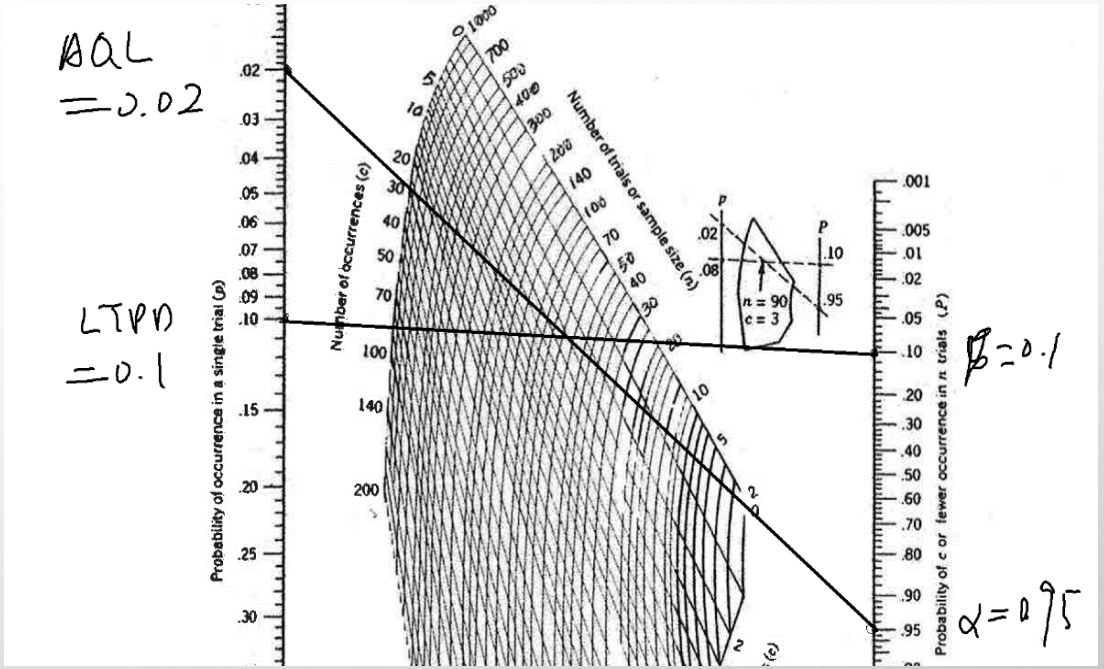
future



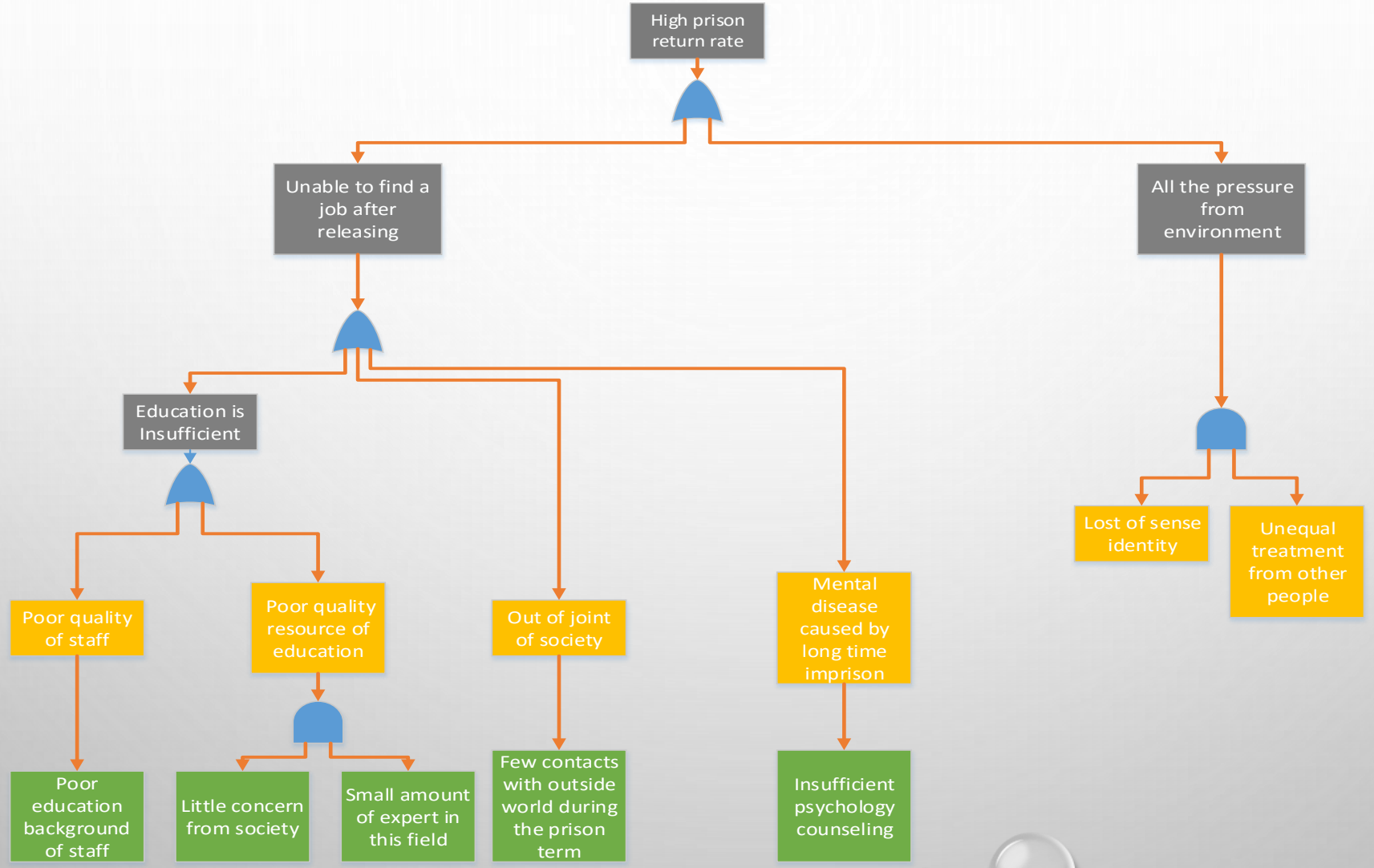
OC Plan

	OC Function Example		(See sheets 1 and 2)
	n	68	c 10
	PD	Pa	
	0	1.00000	
	0.01	1.00000	
	0.02	1.00000	
	0.03	0.99999	
	0.04	0.99992	
	0.05	0.99947	
	0.06	0.99769	
	0.07	0.99264	
	0.08	0.98133	
	0.09	0.96019	
AQL	0.1	0.92597	
	0.11	0.87668	
	0.12	0.81224	
	0.13	0.73469	
	0.14	0.64775	
	0.15	0.55619	
	0.16	0.46494	
	0.17	0.37840	
	0.18	0.29993	
	0.19	0.23163	
LTPD	0.2	0.17439	
	0.21	0.12807	
	0.22	0.09180	
	0.23	0.06425	
	0.24	0.04395	
	0.25	0.02938	





FTA of high return rate



Introduction

Statistical process control (SPC) is an application of statistical methods to the measurement and analysis of variation in a process in order to monitor and control it.

Monitoring and controlling the process ensures that it operates at its full potential. At its full potential, the process can make as much conforming product as possible with a minimum (if not an elimination) of waste (rework or scrap).

SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. Key tools used in SPC include control charts; a focus on continuous improvement; and the design of experiments.

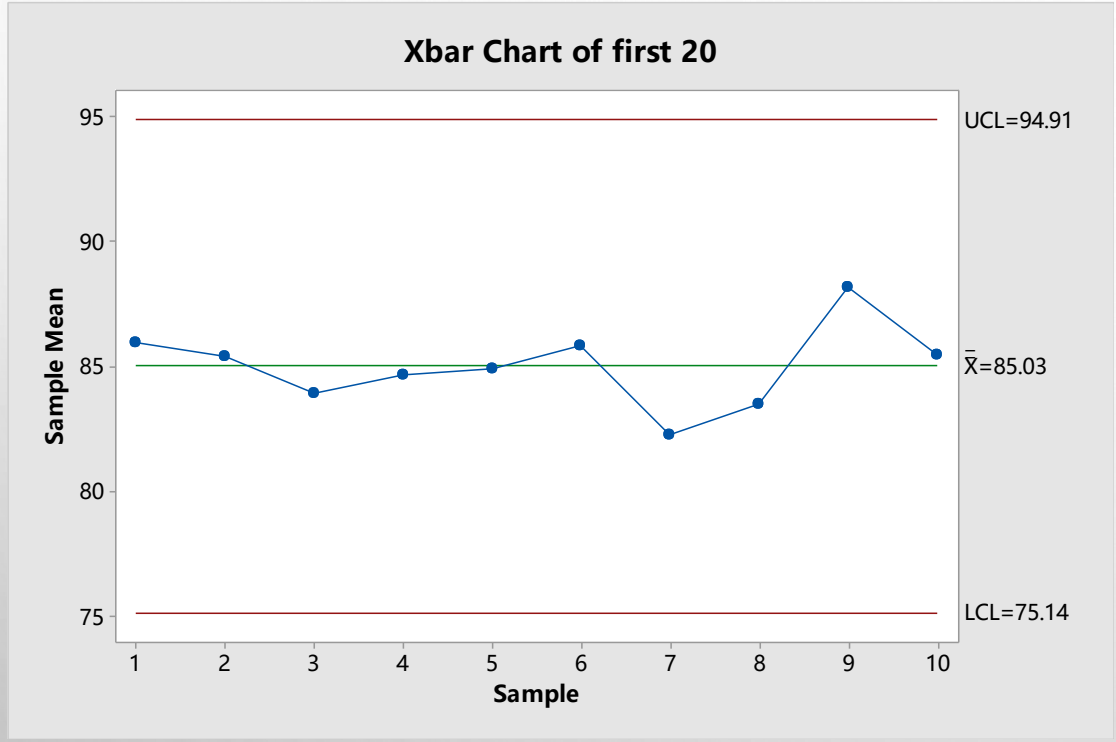
Variables Charts

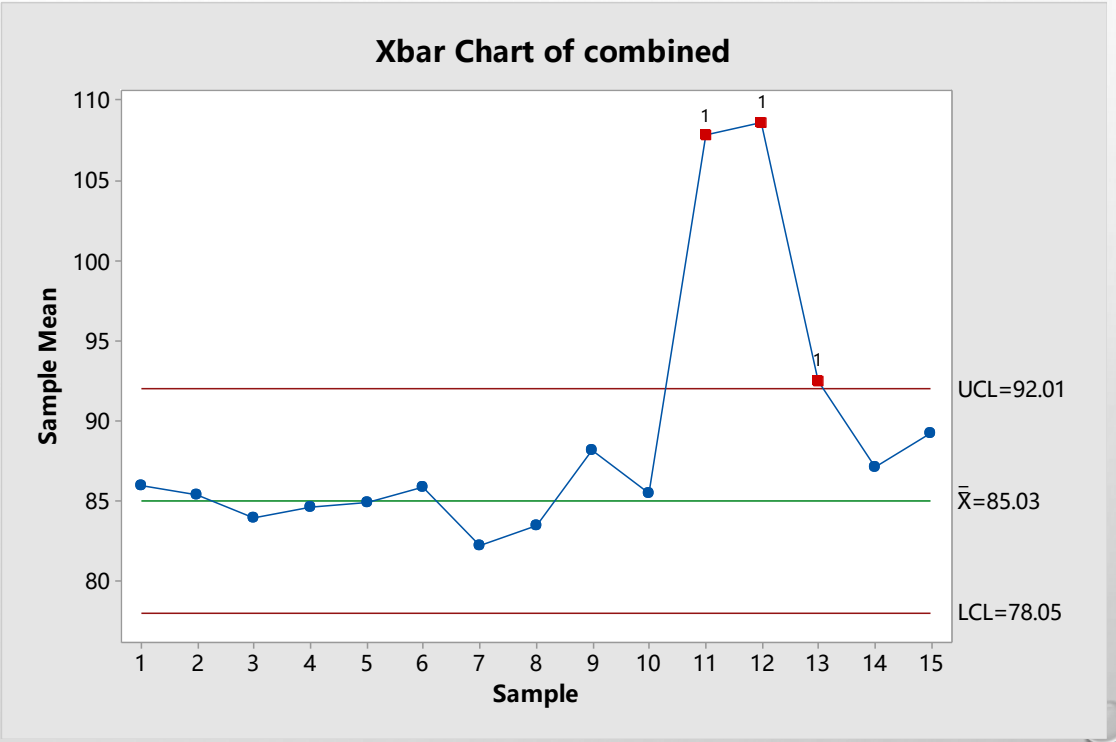
For variables data (or continuous data), the control chart for sample average and sample ranges provides a powerful technique for analyzing process data.

C1	C2	C3	C4
first 20	second 5	third 5	combined
88	109	84	88
84	106	82	84
88	109	92	88
82	108	89	82
84	102	90	84
84			84

A small sample (e.g., five units) is periodically taken from the process, and the average (X) and rage (R) are calculated for each sample. A total of at least 50 individual measurements (e.g., 10 samples of five each) should be collected before the control limits are calculated. The control limits are set at $\pm 3\boldsymbol{\sigma}$ for sample averages and sample ranges. The X and R values are plotted on separate charts against their $\pm 3\boldsymbol{\sigma}$ limits.

X-Bar Charts


Xbar Chart of first 20
Sample Mean
Sample
95
90
85
80
75
1
2
3
4
5
6
7
8
9
10
UCL=94.91
X̿=85.03
LCL=75.14


Xbar Chart of combined
Sample Mean
Sample
110
105
100
95
90
85
80
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1
1
1
UCL=92.01
X̿=85.03
LCL=78.05

Attributes Charts

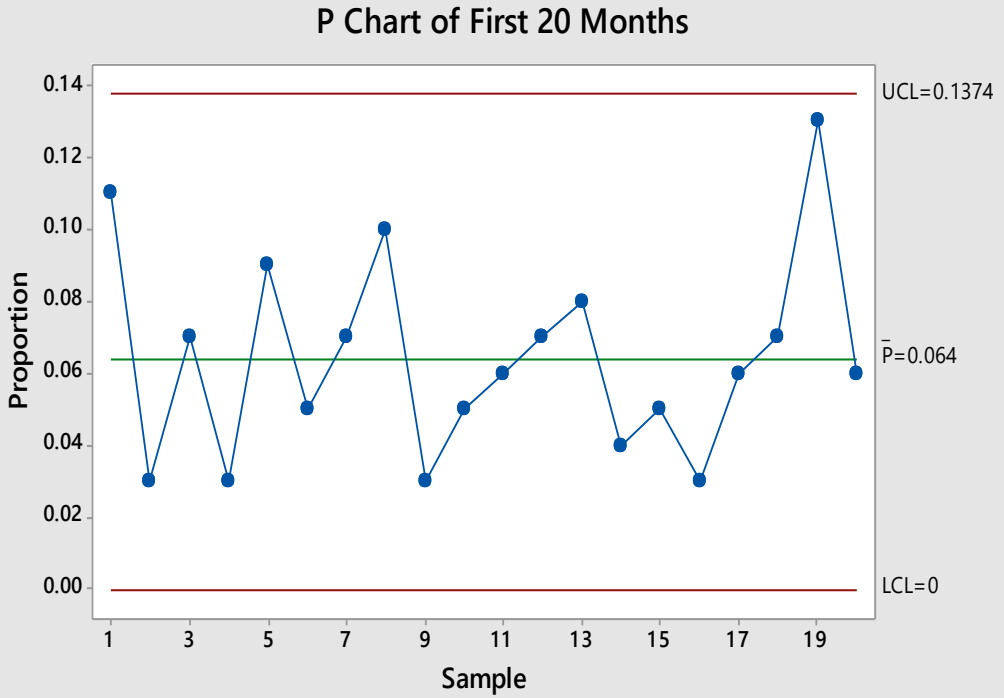
Control charts for X, R, and X require actual numerical measurements, e.g., line width from a photoresist process. Control charts for attribute data require only a count of observations of a characteristic, e.g., the number of nonconforming items in a sample.

The attribute quality chart of 30 months for return prisoner. The simple size of 100 is used.

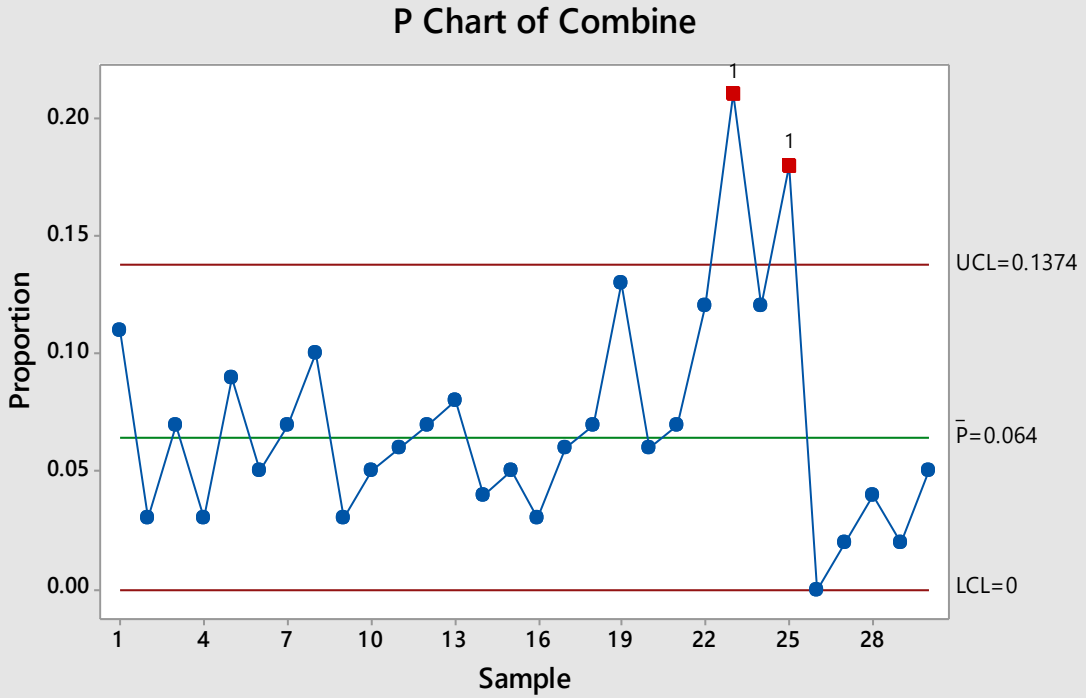
	A	B	C
1	First 20 Months	21 - 25 Months	26 - 30 Months
2	11	7	0
3	3	12	2
4	7	21	4
5	3	12	2
6	9	18	5
7	5		
8	7		
9	10		
10	3		
11	5		
12	6		
13	7		
14	8		
15	4		
16	5		
17	3		
18	6		
19	7		
20	13		
21	6		

Number of returning prisoners

P Charts

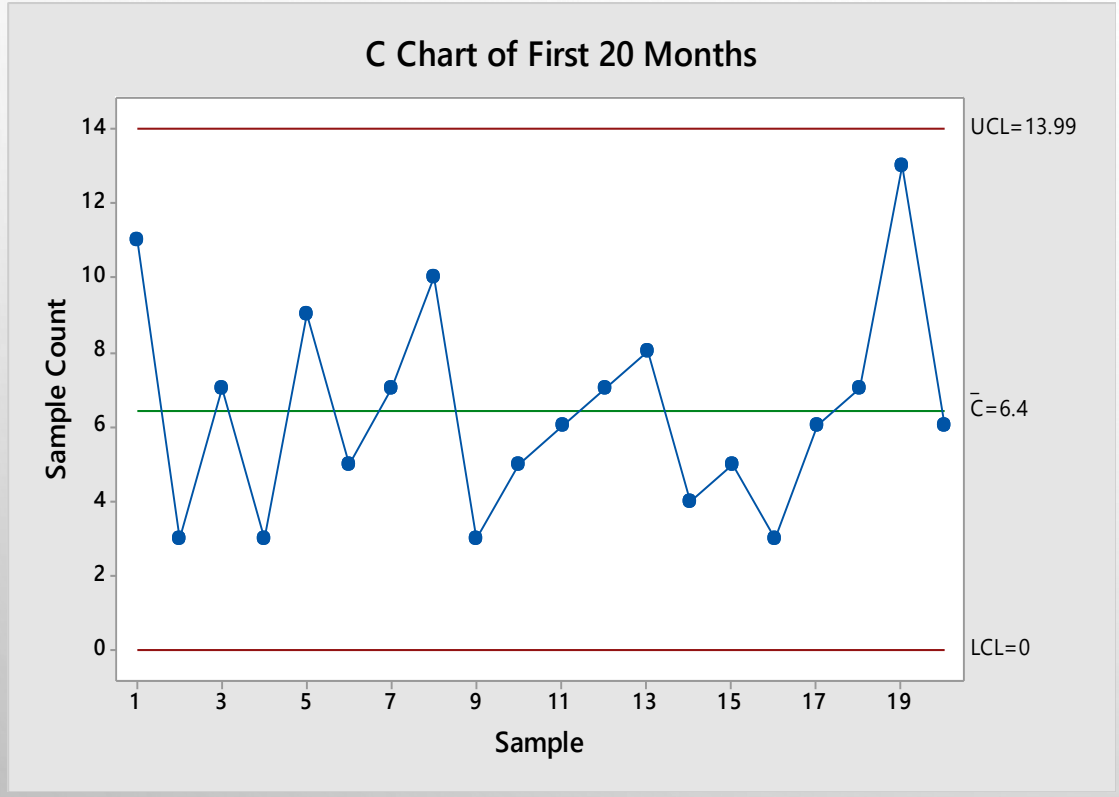


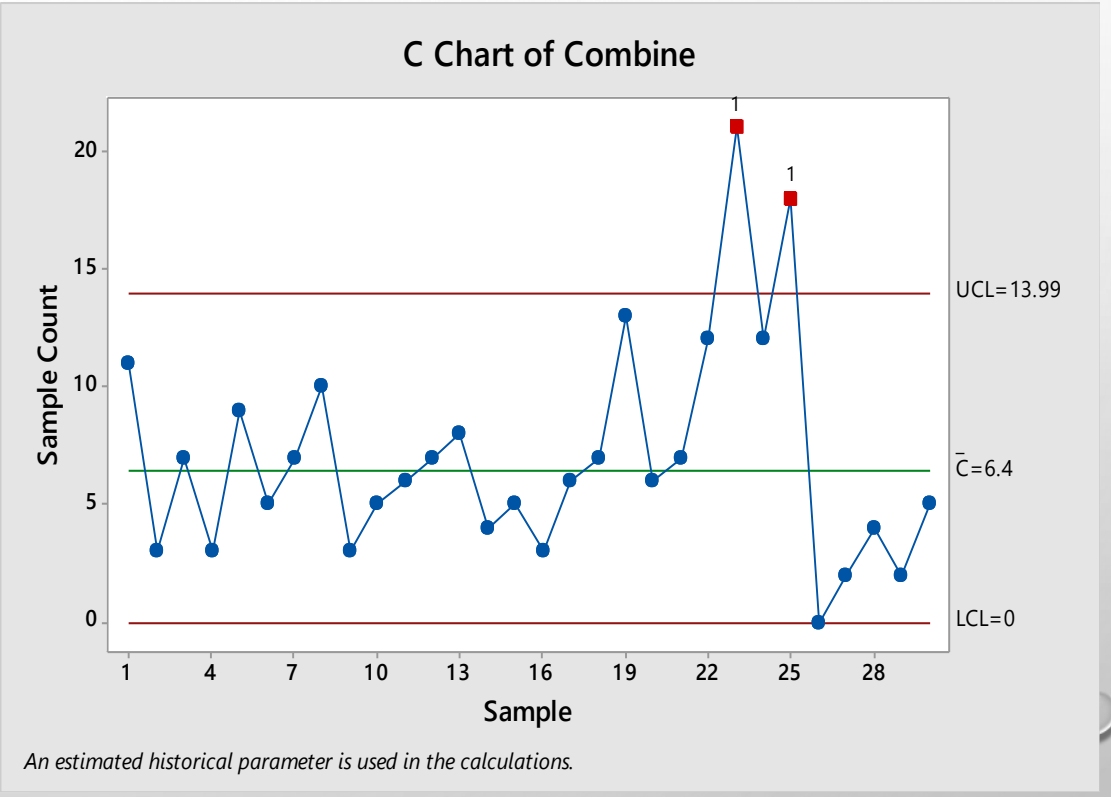
An estimated historical parameter is used in the calculations.



An estimated historical parameter is used in the calculations.

C Charts





An estimated historical parameter is used in the calculations.

Conclusion

- The percentage of returning prisoners decreases from 15.7%, which from 2005 to 2014, to 6.4% of released prisoners obtained by improvement activities.
- The two improvements which analyzed by the DOE, increasing the cost of education and training and locking prisoners who did minor crimes at home, play significant role among all our activities.
- With the decrease of return prisoners' number, the population in prison will goes down which solves the social problems, e.g., the cost of security and food support in jail, the guardianship over children.
- The result is detected by statistical process control (SPC), it is also able to monitor the stability of the process.

THANK YOU AND WELCOME QUESTIONS

Group 8