To Improve Manufacturing Process with the Help of Statistical Process Control (SPC)

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Abstract— The importance of quality has been long recognized in the business environment in order to obtain or manufacture higher quality products. In a manufacturing environment, quality improves Reliability, increases productivity and customer satisfaction. SPC study is a very important tool in production process in order to achieve the Process variation. It is also used to define process capability and stability. Process capability is shown by Cp. The Cp index is used to summarize a system's ability to meet two-sided specification limits (upper and lower). The higher the Cp value the smaller the spread of the system's output. Cp is a measure of spread only. A process with a narrow spread (a high Cp) may not meet customer needs if it is not centered within the specifications. Cp and Cpk will be equal when the process is centered on its target value. If they are not equal, the smaller the difference between these indices, the more centered the process is.SPC study is performed in any of process in industries. In this, I will be study with the help of SPC, online Control Charts at workplace to find out the variation in the manufacturing process.

Key words: Statistical Process Control, Improvement of Manufacturing Process Variation, Productivity Improvement, Sigma Level, Quality Improvement

I. INTRODUCTION

In this era of strains on the resources and rising costs of manufacturing, it becomes increasingly apparent that decisions must be made on facts, not just opinions. Consequently, data must be gathered and analyzed .This is where statistical process control (SPC) comes in. For over 70 years, the manufacturing area has benefited from the tools of SPC that have helped guide the decision making process. In particular, the control chart has helped determine whether special cause variation is present implying that action needs to be taken to either eliminate that cause if it is has a detrimental effect on the process or to make it standard operating procedure if that cause has beneficial effect on the process. If no special cause variation is found to be present, SPC helps define the capability of the stable process judge whether it is operating at an acceptable level.

A. Importance of Statistical Process Control

- Determining the capability of the manufacturing process
- Once the process is stable, provide process capability analysis with comparison to product tolerance.
- More uniform quality of production.
- Reduce % of rejection and rework process
- Saves the cost of material.

II. METHODOLOGY & IMPLEMENTATIONS OF SPC

- Software: SPC Software

Procedure to implantations of SPC:

A. Machine Identification on the Basis of Yearly Rejection Data

The rejection data helps to identify machines having process incapability.

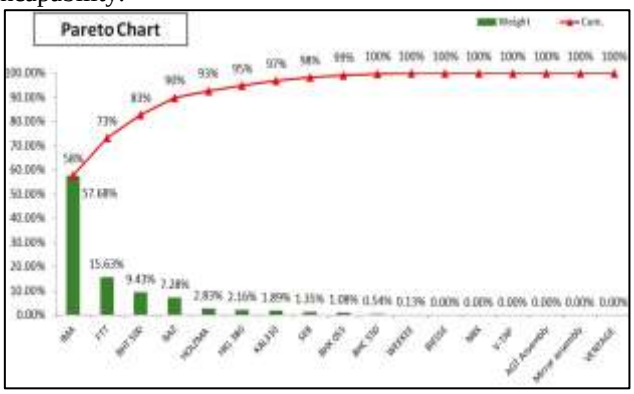

Fig. 1: Pareto Chart of Rejection Data

B. Product Identification on the Basis of Critical Dimensions given in Drawing

SPC 2017-18 Machine Wise Component Details

Sl No	Process	Machine Name	Component Name	Drawing Number	Rev. No	Parameter	Dimension	Tolerance
			Wood Department					
1	Lipping	IMA	King Bed	PL13-A3-040914	A6	Final Width	910	±0.6
2	Drilling	FTT	Side Board Of King Bed	PL13-A3-040912	A1	E To C	14.1	±0.2
3	Drilling	BHT	Drawer Back Of King Bed	PL13-A3-040919	A1	E To C	19	±0.6
			Metal Department					
1	Bending	M/c No. 21	Back Panel Floor and Top Unit 1	PL13-A3-023308	2	Thickness	10	±0.2
2	Bending	M/c No. 21	Back Panel Floor and Top Unit 2	PL13-A3-023308	2	Height	899.5	±0.2
3	Spot Welding	SPM Machine	Spacio Frame (800 mm W) 1	DOS128213	A3	Width	600	-0.3/+0.2
4	Spot Welding	SPM Machine	Spacio Frame 2	DOS128213	A3	Bottom tube Location	155	±0.5

Fig. 2: Product Identification

C. Run Chart

Run Chart shows the running of process with the help of data collection of sampling inspection.

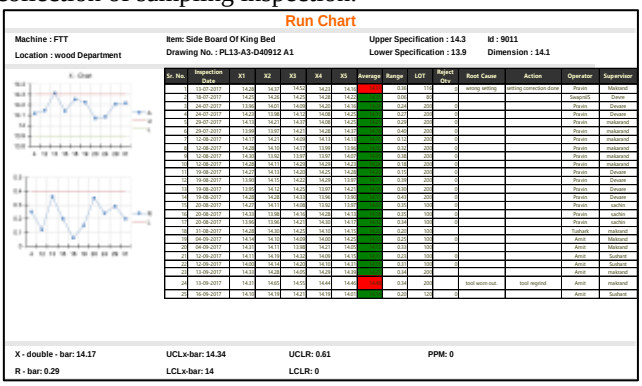

Fig. 3: Run Chart of Manufacturing Process

D. Analyzing Run Chart Trends

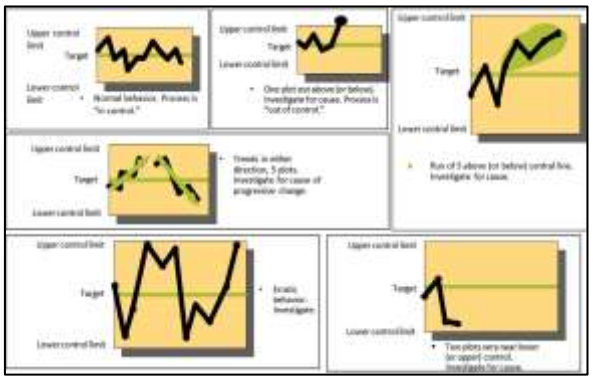

Fig. 4: Patterns in Run Chart

E. Process Capability Report

Process Capability report shows Histogram Limits (With and without), X-Chart, R-Chart, Cp and Cpk value with the help of data.

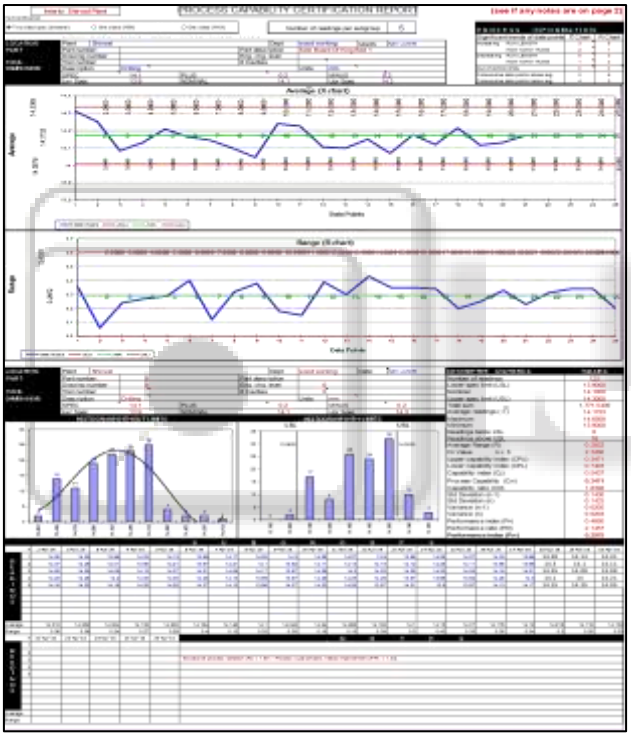

Fig. 5: Process Capability Report

F. Summery Sheet of UCL/LCL & CP, CPK

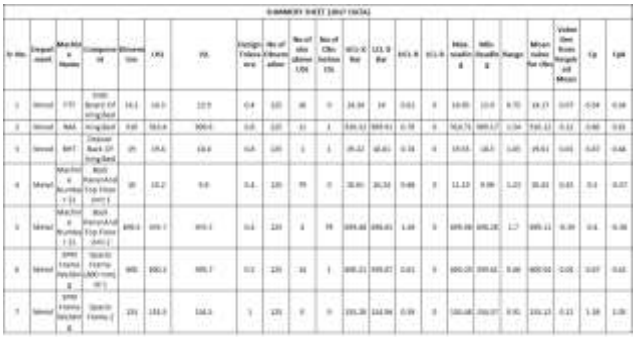

Fig. 6: Summery Sheet

For Conclusion Below points are considered					
Cp or Cpk					
	0 to 0.5	Or	(-) ∞ to 0.5	Process is very poor , Take immediate Action	NOTE
	0.5 to 1.33	Or	0.5 to 1.33	Process needs correction	a) For Capable Process: Cp>=1 and Cpk>=1
	1.33 to 1.67	Or	1.33 to 1.67	Process is good but still improvements is required	b) For six sigma Cp>=1.33 and Cpk>=1.33
	above 1.67	Or	above 1.67	Process is excellent	c) Cp= Process within tolerance, (if Cp >1 all component within olerance, Cp=0 to 1- any value is out of tolerance)
					d) Cpk = Process is nearer to Mean Value (Cpk = - ve, value at lower or out of tolerance at lower side, Cpk =+ v, value at higher or out of tolerance at higher side)

Fig. 7: Standard Table

G. Identify Root cause of Process Variation with the Help of WHY Analysis

FTT Machine			
Data Observation	WHY WHY	Root Cause	Action Decided
Process :- Drilling	**Why 1** :- Panel moving from set location during machine operation	Vacuum cup spring not functioning properly	1)Few damaged vacuum cups to be replaced. 2)Springs for cup need to be changed.
Item :- Side Board King Bed			
Parameter :- E To C	**Why 2** :- Vacuum cup failed to hold panel properly.		
Dimension:- 14.1 (±0.2)			
Observations :-14.37, 14.52, 14.33,	**Why 3** :- Vacuum cup spring not functioning properly		
14.65, 14.55, 14.44, 14.46			
Remark :-Abrupt variation in readings.			

Fig. 8: WHY Analysis of Machine

H. Action Plan for Root Cause

Action plan for prevention of root cause

FTT - Action Plan			Status
	Before	After	
1	Vacuum cups observed damaged.	Damaged vacuum cups replaced.	October
2	Vacuum cup spring - Malfunctioning	Vacuum cup spring changed.	October

Fig. 9: Action Plan

I. Control Chart

This chart helps to identify process variation and improvement of CP, CPK value after action plan.

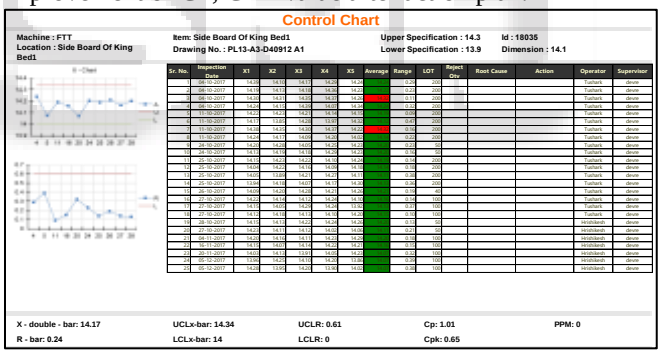

Fig. 10: Control Chart of Manufacturing Process

III. RESULT & DISCUSSION

A. Improve CP, CPK

Process: Drilling	
Machine: FTT	
Component: Side Board King Bed	
Parameters: E to C	
Dimension: 14 (+/- 0.2)	
Before	After
Cp: 0.54	Cp: 1.01
Cpk: 0.34	Cpk: 0.65
Sigma Level: 1	Sigma Level: 1.9

Table 1: Before and After CP, CPK Value

B. Discussion about Improvement of CP, CPK

1) Process variation directly effect on Cp, Cpk and sigma level.

2) SPC helps to determine process variation.
3) Various quality tools are used to determine root cause of process variation and helps to reduce process variation.
4) Reduction of process variation result in improvement of Cp, Cpk value, sigma level and achieve stable and predictable process

C. Improve Productivity

Month	Sum of Ok Qty
April'17	27711
Aug'17	20297
July'17	25417
June'17	25958
May'17	22646
Oct'17	33043
Sept.'17	28607

Table 2:

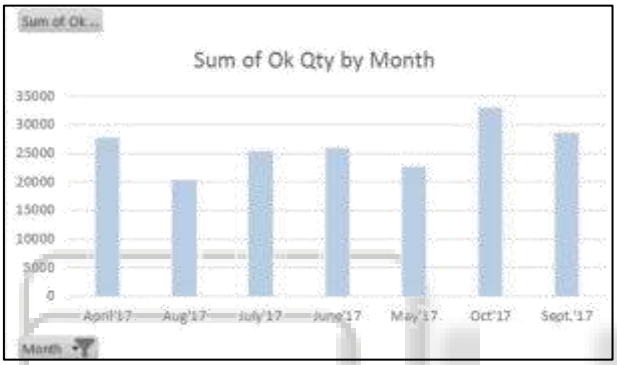

Fig. 11: Graphical Representation of OK Quantity

Month	Sum of Rej Qty
April'17	19
Aug'17	0
July'17	0
June'17	56
May'17	28
Oct'17	0
Sept.'17	0

Table 3:

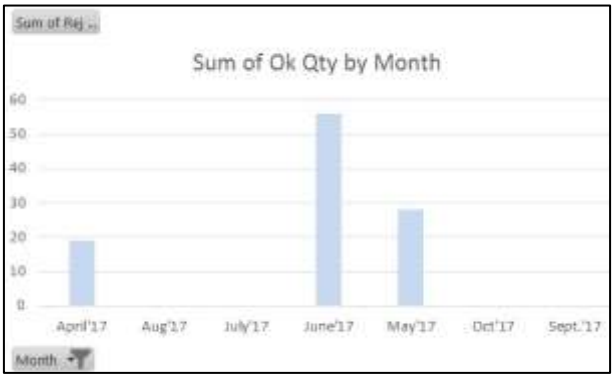

Fig. 12: Graphical Representation of Rejection Quantity

D. Discussion about Improvement of Productivity

1) Process variation effect on production.
2) Increase Cost of inventory due to rejection and rework process.
3) Time consumable for rework process.
4) The stable and predictable process result in rejection % are less.
5) The stable and predictable process result in production rate increase. (Ok quantity).

IV. CONCLUSION

- Due to SPC Productivity is Improved by 0.04%
- Due to SPC Zero % rejection and rework process
- Increase Cp, Cpk Value effect of SPC implementation.
- Increase sigma level.
- Quality improvement by eliminating process variation.
- Due to Improved quality Customer Satisfaction is achieved

V. FUTURE SCOPE

Future scope for SPC is Integrated Wireless Vernier to be linked with Software (via Wi-Fi or Bluetooth) for directly capturing the Data.

Fig. 13: Integrated Wireless Vernier

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