Process Capability Analysis as a Means of Decision Making in Manufacturing Company

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ABSTRACT

This Research, the process capability analysis as a means of decision making in manufacturing company was aimed, to investigate whether the production process is in control, to investigate whether the specification limit of the company is properly centred, to examine the process capability of the company and to state if the process is capable or not.. The method use in the control chart are X and R chart. Also the analysis of process capability was used. It was discovered that the specification limit of the company is not properly centred i.e. off centred. It is recommended that in order to achieve continuous improvement of the process, the company should always attempt to redefined the voice of the process to watch and them to surpass the expectation of the customers. Also, the company specification limit should be redefined to be properly centred and to meet customer requirement.

Keywords

Process, Capability, Specification Limit, Process Control, Decision Making

I. Introduction

The survey is being carried out to know the extent of the use of process capability analysis by an industry in kwara state. In this era of overgrowing competition among industries, it has become absolute necessary for business man to keep a continuous watch over the quality of product or goods produced. The quality of a production at times contains amount of variability, what can we attribute these variations to? Is it the lukewarm attitude of the plant operator towards its responsibility, difference among workers or differences among raw materials e.t.c. The input of a process usually has at least one or more measurable characteristics that are used to specify outputs. These can be analyzed statistically, where the output data shows a normal distribution, the process can be described by the process mean(average) and the standard deviation [4].

Furthermore, a process needs to be established with appropriate process control in place. A control chart analysis Is used to determine whether the process is "in statistical control" if the process is not in statistical control then capability has no meaning therefore the process capability involve only common cause variation and not special cause variation. In this Research we take a critical look at the procedure involved before a process capability is achieved. The industry covered in the survey makes use of process capability to keep their products at an acceptable standard before marketing them. Therefore, for the producers to achieve their desire aim i.e. profit making a continuous watching over of the product coming off the production line in any industry demand necessary and essential to meet the tastes of the customers[6].

II. What is Process Capability

Process capability is the long-term performance level of the process after it has been brought under statistical control. In other words process capability is the range over which the natural variation of the process occurs as determined by the system of common causes[6].

There are two primary capability indices used to measure process capability.

- Cp is the capability index. It measures how well the data fit between the upper and lower specification limits. The higher the value, the better the fit.
- Cpk is the centering capability index. It measures how well the data is centered between the specification limits. The higher the value the more centered the data [4].

II. Literature Review

Process capability is the long-term performance level of the process after it has been brought under statistical control.The use of process capability was adopted as far back as 1920s. It was used to measures the variability of the output of a process and to compare that variability with a proposed specification or product tolerance [2-3, 5].

According to 1S0 (15504) defined process capability as a process to its purpose as managed by an organization management. For information technology, 1S0 (15504) also specifies a process capability measurement framework for assessing process capability. The measurement framework has been generalized so that it can be applied to non IT processes [1, 6].

Another article explained that in order to achieved continuous improvement one must always attempt to redefined the voice of the process" to match and then to surpass the expectations of the customer[3]. Process capability indices are used effectively to summarize process capability information in a convenient unit less system. These indices are Cp, Cpl, Cpu and Cpk [2].[3] in his article discussed that the indices for process capability are based on the assumption that the underlying process distribution is approximately normal.Furthermore, [5-6] in their journal of quality technology (2003) explained that the data chosen for process capability study should attempt to encompass all natural variables. Also, the number of sample used has a significant influence on the accuracy of the Cpk estimates. Therefore smaller samples will result in even larger variations of the Cpk statistics.

Process capability is often thought as being purely on industrial discipline because it is in industry that it has had its widest adoption. Thus, this review will not be completed if mention is not made of some of the researchers who have made similar research. Among them is Shewart after studying way of statistical quality control, also originated the control charts. This is a very effective mode of quality control and process capability. Another

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related work was that of Owoseni (1998). His own research was on the use of statistical quality control and process capability in Oshogbo steel rolling.mills.

IV. Methodology and Procedure

A. Control Chart

The control chart is essentially a graphical device for representing the data obtained so as to directly reveal the frequency and extent of variations from established standards. Control charts are simple to construct and interpret. They inform the quality controller at a glance when the process is out of control, or in a state i.e. within the tolerance limits specified by the product engineer.

Hence, it is regarded as a graphical means of analysis which have proved easy to maintain. The procedures in preparing a control chart by the industry are as follows:

1. To collect samples at regular intervals or after production
2. To compute an appropriate statistics of product under consideration such as its range, sample mean etc.
3. To plot the statistics of the particular product on a chart as a function of sample number of time to reflect the quality of the remaining products.
4. To calculate the control line, upper control limit and ower control limit.
5. To observe the change and conclude

A control chart is made up of three lines.

- Central line (CL) which indicates the standard of process.
- Upper Control Limit (UCL).
- Lower Control Limit (LCL).

This chart is based on measure of quality characteristic of products and can be express in a specific limit of measurement. It is found to be a more economical means of controlling quality than chart based on attributes significance changes in either the mean or standard derivation are an indication of significant change in process.

$\bar{X}$ - CHART

UCL = $\bar{\bar{X}} + A_2\bar{R}$

LCL = $\bar{X} - A_2\bar{R}$

R – CHART

Center Line (CL) = $\bar{R}$

Upper Control Limit (UCL) = $\bar{R}D_4$

Lower Control Limit (LCL) = $\bar{R}D_3$

$\bar{R}D_3$ is the mean of the ranges in the sample process. A_2, D_4 and D_3 are variables in the appropriate statistical (SQC) table.

V. Process Capability

The process capability is a measurable property of a process to the specification, expressed as a process capability index (e.g. (Cpk or Cp) or as a process performance index (e.g. (Ppk or Pp). The output of this measurement is usually illustrated by a histogram and calculations that predict how many parts will be produced out of specification (005).

A capable process meets customer requirements 100% of the time. Customer requirements are defined using an upper specification limit (USL) and a lower specification limit (LSL).

Process capability is measured by two primary capability indices:

- Cp is the capability index. It measures how well the data fits between the upper and lower specification limits.
- Cpk is the centering capability index. It measures how well the data is centered between the specification limits. The higher the value, the more centered the data index and estimate equation.

Index Symbol	Meaning	Estimate equation
Cp	Capability Index	(USL - LSL)/6s
Cpu	Upper Capability Index	(USL – X-Bar)/3s
Cpl	Lower Capability Index	(X-Bar - LSL)/3s
Cpk	Centering Capability Index	Min of (Cpu, Cpl)

VI. Process Capability Rules of Thomb

1. If Cp >1 process is capable (product will fit between the customer's upper and lower specification limit if the process is centered).
2. If Cpk >1 process is capable and centered between the LSL and USL.
3. If Cp = Cpk the process is centered at the mid-point of the specification limits.
4. If Cp >Cpk the process is off-center.
5. If Cpk = 1 the process is barely capable.
6. If Cpk <1 the process is not capable.
7. Pp is the performance index. Like Cp it measures how well your data fits within the USL and LSL. It uses standard deviation in the calculation instead of sigma estimator.
8. Ppk is the performance centering index. Like Cpk it measures how well your data is centered between the USL and LSL. It uses standard deviation in the calculation instead of sigma estimator.
9. Cp and Cpk should be close in value to Pp and Ppk.
10. If Cp and Cpk are much greater than Pp or Ppk, the process may not be stable.

VII. Data Presentation

Table 1: The weight of Dr. Vamis Oral Rehydration Salt (ORS) night in grams for a month from different machine represented by X_1, X_2, X_3, X_4 and X_5.

Days	X_1	X_2	X_3	X_4	X_5	$\bar{X}$	R
1	16.0	16.6	16.2	16.8	16.0	16.32	0.8
2	17.2	16.5	15.5	17.8	18.0	17.00	2.5
3	17.0	18.0	16.5	17.0	16.4	16.98	1.6
4	16.5	17.5	17.0	17.5	16.9	17.08	1.0
5	16.5	18.0	17.0	17.0	18.3	17.56	1.8
6	16.5	16.2	16.0	15.5	15.5	15.90	1.0
7	16.0	16.2	16.0	15.5	15.6	15.86	0.7
8	17.8	17.2	18.5	17.9	17.9	17.86	1.3
9	19.5	17.0	16.8	16.5	16.5	17.26	3.0
10	18.0	17.5	18.4	18.2	19.2	18.26	2.3
11	18.0	17.9	18.3	16.7	16.7	17.52	1.6
12	16.2	16.2	16.5	18.5	16.4	16.76	2.3
13	17.5	18.5	20.8	17.9	18.4	18.62	3.3
14	18.0	16.7	19.4	15.8	16.8	17.34	3.6
15	19.8	17.8	16.5	18.4	18.5	18.20	4.3
16	16.0	18.0	20.6	17.6	17.6	17.96	4.6
17	17.3	16.8	20.5	16.5	15.8	17.38	4.7

18	16.8	17.4	16.2	17.7	17.7	17.16	1.5
19	17.2	18.6	19.4	16.0	17.0	17.64	4.4
20	15.5	16.8	17.0	17.5	16.0	16.56	2.0
21	19.8	16.0	15.5	16.8	16.9	17.00	4.3
22	17.5	18.5	16.4	15.6	18.0	17.20	2.9
23	16.5	18.0	20.5	19.4	17.5	18.38	4.0
24	20.8	16.2	16.0	17.0	20.4	18.08	4.8
25	15.5	16.5	18.0	20.5	17.0	17.50	5.0
26	14.6	17.5	19.0	18.5	15.0	16.92	4.4
27	18.0	15.5	17.8	16.0	19.9	17.44	4.4
28	17.8	20.5	15.6	17.6	16.0	17.50	4.9
29	16.5	18.8	15.8	15.0	14.5	16.12	4.3
30	19.5	18.0	16.4	16.0	15.5	17.08	4.0

Source : Tuyil Company

Computation for $\bar{X}$ Chart

From the table for n=5, A2=0.577

UCL = $\bar{\bar{X}} + A_2\bar{R}$

= 19.034

LCL = $\bar{\bar{X}} - A_2\bar{R}$

= 15.526

CL= = 17.280

Computation for R-Chart

From the table d_4 = 2.114, d_3 = 0, $\bar{R}$ = 3.04

$UCL_R = d_4$ x R= 2.114 x 3.04

= 6.427

$LCL_R = 0$

$CL_R = 3.04$

Analysis of process capability given the company specification limits as follows:

USL = 17

LSL = 14

1. Capability index Cp

$$Cp = \frac{(USL - LSL)}{6S}$$

For X_1 C_p = 0.42 ,For X_2 C_p =0.49

For X_3 C_p= 0.38 ,For X_4 C_p = 0.45

For X_5 C_p = 0.42

2. Upper Capability Index CPU

$$Cpu = \frac{(USL - X\text{-}3ar)}{3S}$$

For X_1 Cpu = - 0.08, For X_2 CPU = -0.09

For X_3 Cpu = - 0.07, For X_4 Cpu = - 0.08,

For X_5 Cpu = - 0.08

3. Lower Capability Index

$$C_{p1} = \frac{(X\text{-}Bar - LSL)}{3S}$$

For X_1 C_{pl} = 1.09 , For X_2 Cpl = 1.06

For X_3 C_{pl} = 0.84 , For X_4 Cp1 =0. 98

For X_5 C_{p1} = 0.93

IV. Process Capability Index CPK

For X_i

Cpk = Min (Cp1, Cpu)

$$= Min \frac{(USL\text{- }X\text{-}Bar)}{3S}, \frac{(X - Bar - LSL)}{3S}$$

For X_1 Cpk = $Min \frac{(17 - 17.28)}{3x\ 1.20}, \frac{(17.28 - 14)}{3x\ 1.20}$

=Min (-0.08), (0.91)

Cpk = 0.08

For X_2 Cpk= $Min \frac{(17 - 17 .28)}{3x\ 1.03}, \frac{(17.28 - 14)}{3x\ 1.\ 03}$

= Min (- 0.09) (1.06)

Cpk = -0.09

For X_3 Cpk =$Min \frac{(17 - 17.\ 28)}{3x\ 1.30}, \frac{(17.28 - 14)}{3x\ 1.30}$

= Min (-0.7), (0.84)

Cpk = 0.07

For X_4 Cpk = $Min \frac{(17\text{-}17.28)}{3x1.12}, \frac{(17.28\text{-}14)}{3x1.12}$

= Min (-0.08), (0.98)

= - 0. 08

For X_5 Cpk = $Min \frac{(17\text{-}17.28)}{3x1,\ 18}, \frac{(17.28 - 14)}{3x1,\ 18}$

= Min (-0.08), (0.93)

= - 0.08

VIII. Comments

According to the rule of thumb since Cp, Cpu, Cpl and Cpk are less than 1 therefore the process is not capable i.e. the product does not fit between the customers upper and lower specification limits, also, since Cp is greater than Cpk, the process is off- centred.

IX. Conclusion

From the analysis carried out and the results obtained, it was observed that different machine produced different weight of the drug daily.The control chart which consisted of the drug discussed in this research indicated that the process of the drug is in control, and this is the basis basis for capability indices. In references to the data obtained, the analysis carried out and the results obtained, it was discovered that, there are differences in the weight of the drug produced daily due to variation in machines. Also, the process is statistically in control. Furthermore, it was observed that the specification limit of the company is off centred i.e. is not properly centred, since the capability index (Cp) is greater than the centring capability index (Cpk). Therefore the process is not capable. This means that the process does not meets customer requirements 100% of the time.

X. Recommendation

In order to achieve continuous improvement of the process, the company should always attempt to redefined the voice of the process to match and then to surpass the expectation of the customer. Also, the company specification limits should be redefined to be properly centred and to meet customer requirements. The assignable cause of variation in the machine should be corrected. These errors may be changes in raw materials, incorrect processing, temperature or machine speeds, operator errors, or damage to equipment.

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There should be a laboratory unit in every industry and they should increase the number of samples for statistical test. The company should enhance job training for the workers operation in each department.Finally, focuses should be made to reduce the proportion of product or services that does not meet specification, using measures such as percentage of non conforming product.

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