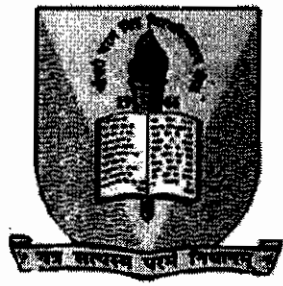



15


File No. 3196

**AN ANALYTICAL STUDY OF SOME
STATISTICAL PROCESS CONTROL PARAMETERS
IN SELECTED INDUSTRIAL SYSTEMS**



**AN ABSTRACT
SUBMITTED TO
CH. CHARAN SINGH UNIVERSITY, MEERUT
FOR THE AWARD OF THE DEGREE OF
DOCTOR OF PHILOSOPHY
In
STATISTICS**

Supervisor: 
DR. VIVEK TYAGI
ASSOCIATE PROFESSOR
NAS COLLEGE, MEERUT

Submitted By: 
LALIT KUMAR
RESEARCH SCHOLAR

**DEPARTMENT OF STATISTICS
MEERUT COLLEGE
MEERUT
2019-20**

ABSTRACT

Statistical Process Control (SPC) is a technique for open or closed loop control of manufacturing processes, based on statistical tools. This procedure helps in monitoring the process behavior. It is a standard method for monitoring and controlling processes on the basis of measurements of randomly selected samples. The main objective of SPC is to ensure that the planned process output is achieved and the related customer requirements are fulfilled.

Different statistical techniques, utilized and discussed in this research endeavor, are as follows viz. Principal Component Analysis, Control Charts, Multivariate Control Charts (Hotelling's T^2), Pareto Diagram, Cause & Effect, Process Capability Indices – Univariate & Multivariate, Scatter Diagram and Histogram.

The objectives of this research study are as follows:

1. To measure & analyze Pareto diagram and Hotelling's T^2 control chart for the manufacturing process of packaging film at U-Flex Ltd., Noida.
2. To conduct Cause & Effect Analysis for the process of manufacturing of CD-Rs at Moser Baer (I) Ltd., Greater Noida.
3. To measure and analyze Capability Indices – Univariate and Multivariate for the process of manufacturing of Kraft paper at Paswara Papers Limited, Meerut.

Under the scope of this research, three different process industries viz. U-Flex India Ltd., Noida, Moser Baer (I) Ltd., Greater Noida and Paswara Papers Ltd., Meerut have been studied.

In case of U-Flex India Ltd, Noida, Multivariate Statistical Process Control (MSPC) chart has been utilized to monitor packaging film production process. Firstly, Pareto Analysis has been performed to identify the critical process variables for minimizing the rejections and then Hotelling's T^2 chart with Principal Component Analysis (PCA) is administered to investigate the critical process variables.

In the study of 200 samples, consisting 5 observations in each, the application of Hotelling's T^2 control chart reveals that for 176 and 187 observations, Re-winder Tension is flagged out-of-control in MSPC chart, the same was gesticulated in control in USPC chart. For observation 183, Re-winder Tension is flagged out-of-control in both MSPC and USPC. For the observations 167, 183 and 187, Line Tension is flashed out-of-control in both MSPC and USPC. Ash content is flagged out-of-control in MSPC charts for observations 164,167,176 and 185 but is motioned in control in USPC charts.

In case of Moser Baer (I) Ltd., Greater Noida, analysis of the defects that lead to the rejection of the product has been done through Cause & Effect Diagram, also known as Fish bone diagram or Ishikawa diagram to identify the prominent causes.

Four months data has been collected from the shop floor of the CD-R Division of the company. Average monthly percentage of the defects has been considered for the study. Then, all defects of CD-R have been analyzed using Cause & Effect diagrams that divulge the possible causes of the respective defect. Corrective Actions and Preventive Actions (CAPA) are suggested to eradicate or for minimizing the defects and hence losses.

- Impart the regular training to the technicians to make them skilled.
- Pulverization process must be adopted after every shut down of the machine.
- Proper adjustment of mold box on IMM.
- Proper adjustment of stamper on clamping end at regular intervals.
- Dry the raw material, polycarbonate granules, properly at 120° C for 2-3 hrs before putting it into the barrel of IMM.
- Regular checking and adjustment of robotic arms and conveyor belts in the Line Machine.
- Calibrate the PLCs of IMM and Line Machine at regular intervals.
- Regular checking for distorted stamper, and for materials going to be exhausted.

Further, in case of Paswara Papers Ltd., Meerut, the production process of kraft paper has been studied and analyzed.

Observed data (500 samples) of 3 months has been collected from the shop floor of Paswara Papers Ltd, Meerut. Normality tests have been carried out for various measured variables using Jarque Bera Test. Transformation function, Inverse DF, has been used to normalize the data variables.

Using the technique of multiple regression, keeping GSM as dependent variable, relationship with critical independent variables viz. BF, Cobb, RCT (CD), Bulk, Caliper Thickness, Ply Bond, Paper Ash and Moisture, have been identified and it has been found that F-value (ANOVA) is resulted as 175.58 with p-value .000 (less than 0.05), shows that there is the significant relationship between the variables at 95% level of confidence. Further, it is suggested to simplify the model by removing "Ply Bond" as independent variable since individually, it has the highest P-value (0.1515), greater than 0.05, reveals that it is statistically insignificant at 5% level of significance.

Subsequently, Univariate Capability Indices have been computed. The calculation reveals that all the quality parameters under study enjoy C_p more than 1 except Cobb ($C_p = 0.65$) and RCT (CD) ($C_p = 0.89$), that verifies that the process is under control and capable enough to meet the specifications, hence approx. 99.73% process region is centered within the boundaries of the tolerance. Thereafter, C_{pk} , C_{pm} , C_{pmk} have been computed to analyze the process capability.

Multivariate Capability index has also been computed for significantly correlated variables viz. Cobb-RCT (CD) and BF-Paper Ash. MC_{pk} for respective combinations have been computed as 0.17 and 0.40, verifies that the variables in both the combinations are highly correlated and one or both variables are beyond the specifications.