Analysis Of Accuracy Multivariate Control Chart T2 Hotelling Free Distribution With Outlier Removal

(Case Study: Production Process Ink at PT. EPSON Batam)

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Abstract

The quality of products are competitive advantage for PT EPSON Batam-Indonesia. One of their products is ink, its quality are controlled by collecting data during 1st April 2014 till 7th July 2014 and use these data to set up a control chart on five variables, namely, Viscosity / viscosity (DPAs), pH, Surface Tension , Wavelength (Å), and Particle Size (m). We noted that 14 points plot above the upper control limit, so the process is not in control.These points must be investigated to see whether an assignable cause can be determined. However, analysis of the data (chamber process) does not produce any reasonable or logical assignable cause for these, and we decide to retain the point and conclude that the process is in control. This indicates that we have false alarm, so clearly this is an important issue to consider in control chart implementation. The ink quality is determined by five variables which are multivariate in nature, while PT EPSON Batam is applying univariate control charts to each individual variable. Control chart is basically used on data having normal distribution, but in fact the data we have is not normal distribution so Chebyshev theorem for free T2Hotelling control chart distribution can be applied. In addition, to address the presence of outliers, the control chart is constructed without outliers (outlier data removal). The Accuracy of control chart is evaluated by G-index measurement accuracy. The proposed control chart produced 4 out of control observations and after decomposition analysis are known that the cause of out of control occurrence are the variable of the surface tension and viscosity. In addition, the accuracy of the free distribution T2Hotelling control chart, 97.94% shows that the control chart can be used for future samples.

Keywords: False alarms, multivariate Chebyshev theorem, free distribution T2 Hotelling control charts, the level of accuracy of the control chart, the G-index, Outliers

I. INTRODUCTION

As a manufacturing company, which is directly supervised under the EPSON Company in Japan, PT EPSON Batam always made quality and service of their product as a top priority. To monitor the quality of goods, PT EPSON Batam is formed a QA(Quality Assurance) Departmentwhich responsible for the quality of products, in every production unit. To assure the quality of ink, PT EPSON Batam gives more attention to the ink's characteristic. To control the ink quality PT EPSON Batam use $\bar{x}$ control chart.

Based on results of observations made during1st April 2014 till 7th July 2014 it is known that there are 14 out of control observations. Then a chamber process is done to those fourteen observations.Based on the result of the chamber process, those fourteen observations are still includedinto the good quality products. The chamber process indicates there are incorrect out-of-control signal or falsealarm generated by the control chart.

Because the ink quality is influenced by several characteristics, such as viscosity, pH, surface tension, wavelength, and the size of the particle, then to reduce false alarm we suggested the implementation of multivariate control chart instead of univariate control chart as used by PT EPSON Batam.

The control chart analysis is applied to a normal distributed data but in fact the data is not normally distributed. This practice will cause the false alarm too. To tackle this problem, Chebyshev theory is implemented so that the data on the control chart is stated as distribution free. After forming a control chart, we evaluate the accuracy of control chart using G-index by forming a 2x2 contingency table between the chart result and the real condition based on observation.The purpose of this research is to obtain inaccurate control chart to control the ink's characteristics.

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II. LITERATURE

A. Multivariate Analysis

According to Johnson [2], univariate analysis is performed o analyze avariableoreachvariable tothe observations result. Univariate analysis serves to summarize the results of the measurement data so the data can be transformed into useful information. While the multivariate analysis is related to more than two variable analyzed simultaneously based on a sample of multivariate observations.

TABLE I. MULTIVARIATE DATA STRUCTURES

Observation-i	Variable (X_1)	Variable 2 (X_2)	Variable 3 (X_3)	…	Variable p (X_p)
1	x_{11}	x_{21}	x_{31}	…	x_{p1}
2	x_{12}	x_{22}	x_{32}	…	x_{p2}
…	…	…	…	…	…
m	x_{1m}	x_{2m}	x_{3m}	…	x_{pm}

B. Correlation Test among Variables

Variables $\boldsymbol{x}_1, \boldsymbol{x}_2, \dots, \boldsymbol{x}_p$ are independent if the correlation matrix between variables is an identity matrix. To test the independence between these variables we can conduct a Bartlett Sphericity test with the following hypothesis formulation [6]:

H0:R=I (variable ink characteristics mutually independent)

H1:R≠I (variable ink characteristics mutually dependent)

With the statistics test used is