دهمین کنفرانس بین المللی مهندسی صنایع
Tenth International Industrial Engineering Conference
۷ و ۸ بهمن ماه ۱۳۹۲
27-28 January, 2014

Development of Fuzzy Process Capability Indices P_p, P_{pk}

Soroush Avakh Darestani*
[1]Faculty of Industrial and Mechanical Engineering, Islamic Azad University, Qazvin Branch
Qazvin, Iran
avakh@qiau.ac.ir

Mina Nasiri[1]
m.nasiri1988@gmail.com

***Abstract*— Process capability indices (PCIs) measure actual or the potential performance of process indicators to the target and specification limits. PCIs and control charts can be mentioned as two useful and applicable tools to measure the product quality and process performance. In this research, the fuzzy set theory is used to give more information and flexibility of PCIs. Both triangular fuzzy number (TFN) and trapezoidal fuzzy number (TrFN) are applied in fuzzy theory. The results show that PCIs such as P_p and P_{pk} are more informative and flexible in fuzzy environment. The proposed methodologies are applied in a first tier supplier for automotive industry in Qazvin's industrial area of Iran.**

Key words-Quality; Control Chart; Process Capability Indices; Fuzzy; Statistical Process Control

I. INTRODUCTION

Statistical process control (SPC) is a powerful tool that was introduced in middle decades of 20th century [1]. Moreover, it used to solve problems like variation on production processes and defecting product. Process capability analyses (PCA) plays an important role in improving the quality of the products [2].

PCA can be defined as the ability of a process to deal with customer requirements which is defined as specification limits (SLs). Process capability indices (PCIs) are the main outputs of PCA which give a numerical measure of whether a production process is capable of producing items within the specification limits predetermined by the consumer. If the certain minimum values of PCIs have been achieved, the process is named as ''capable process" that it has a success for meeting SLs. If these minimum values cannot be met, the process is named as ''incapable process". PCIs indicate C_p, C_{pk}, C_{pm},C_{pmk} , P_p, P_{pk} [3].

Majority of the studies for developing the process capability are on crisp. But accessing crisp data all the time is not available. Most of the measurement tools do not have the ability to show the precise number as the products' qualities are not exact. Using fuzzy logic can solve the problem and makes a good relation between computer language and human deal with such problems. Indeed, fuzzy set theory is a line of mathematics that lets a computer to simulate a real world in the same way that people do as taking imprecise data may be more effective and applicable in industry [4].

II. TRADITIONAL PROCESS CAPABILITY INDICES

The PCA and SLs are comparing with each other by using PCIs. Several PCIs such as C_p, C_{pk},C_{pm}, C_{pmk}, P_p,$P_{pk}$are used to approximate the capability of a process. The index C_p which is the first named precision index [5] defined as the ratio of specification width (USL - LSL) over the process spread (6σ). The specification width stands for customer and/or product expectations. The process variations are inversely related with specification width. It means that if the process variation is very large, the C_p value is small and it represents a low process capability. C_p shows how well the process fits within the two specification limits. The computation of $C_p$is used by "(1)" [6].

$$C_p = \frac{USL-LSL}{6\sigma} \quad (1)$$

σ is noted as the standard deviation of process which is calculated according to "(2)". USL and LSL are upper and lower specification limits. The process capability ratio C_p does not take into consideration where the process mean is placed relative to specifications [6]. C_p Concentrates on the distribution of the studied process and does not concentrate on centering the process and thus gives no warning of the real process performance. [5] Introduced C_{pk} index to solve this problem. The C_{pk} is used to provide a warning of the variability connected with a process. It illustrates how a process confirms to its specifications. The index is usually used to relate the ''natural tolerances (3σ)" to the specification limits. C_{pk} Explains how well the process fits within the