Construction of fuzzy X-S control charts with an unbiased estimation of standard deviation for a triangular fuzzy random variable

ABSTRACT

Statistical process control and Shewhart control charts are used by organizations to aid in process understanding, assessing process stability, and identifying changes to improve the quality of the product. Shewhart control charts only considered uncertainty caused by randomness while in practice, uncertainty caused by vagueness, ambiguity, and/or incomplete information are also observed. In this article, fuzzy $\bar{X} - S$ control charts which handle both kinds of uncertainty simultaneously are developed using fuzzy random variables. For this purpose, the unbiased estimation of standard deviation for a triangular fuzzy random variable is introduced and utilized to construct the fuzzy $\bar{X} - S$ control charts. Then, a detailed average run length study is performed to evaluate the decisions regarding sample size and accepted out-of-control level ( ). A comparison study is performed to verify the proposed technique by comparing its performance based on average run length with previous technique in the literature. The result shows that the proposed technique could improve the detection of abnormal shift in process mean 0.1% to 30% depending on sample size and shift. Finally, the proposed fuzzy control charts are validated through a case study of noodle production in food industry.

Keyword: Statistical process control; Fuzzy control charts; Fuzzy random variables; Unbiased estimation of standard deviation