Optimum process adjustment under inspection errors with considering the cycle time of production

Somaye ayeen[1]/ Mohammad Saber Fallah Nezhad, Ph.D[2]/Yahya Zare Mehrjerdi[3]

[1]M.S. Student of Industrial Engineering, Yazd University
Amn.ayeen@yahoo.com
[2]Assistant Professor of Industrial Engineering, Yazd University,
Fallahnezhad@Yazd.ac.ir
[3]Assistant Professor of Industrial Engineering, Yazd University,
Yazm2000@yahoo.com

Abstract

This paper is devoted to the study of determining optimal process mean in two-stage production systems with rework loops. In this paper, we developed an absorbing Markov chain model in production systems where all items are inspected for conformance with their specification limits. When the value of the quality characteristic of an item falls below a lower limit, the item is scrapped. If it falls above an upper limit, the item is reworked, so that rework loops are used for reworking process, because the use of rework loops can significantly increase the system throughput and reduce scrap, cost, etc. This flow of material through the production system can be modeled in an absorbing Markov chain. We included cycle time of production line in model. Also effects of inspection errors are investigated. Numerical examples are given to demonstrate the application of the proposed model.

Keywords; rework loops, Markov chain, optimum process mean, quality inspection.

1- Introduction

Process control is one of the important problems in manufacturing environments. Each quality characteristics of produced item should be adjusted at special mean. When operator starts work of production in the production systems, he should adjust quality characteristics of production process on the certain value. During production of the items in the production process, experts consider certain specifications limits for inspection of the produced item. With comparing the value of quality characteristics in each item with these specification, it is to known, whether the product complies with the limits. If the items are in within the predetermined limits, sold in the market, otherwise they are being considered as waste. After production process, there is an inspection station where in that the product will be examined. If the product needs to be reworking, it returned to production process and a corrective action is performed on it. Inspection process usually is done 100% to reduce the amount of waste. Product is reworked if the value of its quality characteristic falls above an upper specification limit and it is scrapped when it falls below a lower specification limit. Operator adjusts process according to mean value of quality characteristics. When the process starts, if the process mean is set too low, the number of non-conforming items becomes high and high rejection costs is incurred. On the other hand, if the mean value is set too high, then the number of reworking actions becomes high, resulting in a higher reworking cost.

Lee and Elsayed(2002) considered the problem of optimum process mean and inspection limits with allocating alternative variable for inspecting quality characteristics in one of the two-stage process. Al-sultan and Pulak presented a mathematical model for obtaining optimal adjustment point in a two-stage production system and they just considered lower inspection limits. Duffuaa and Gaally(2012) developed multi-objective optimization model which includes profit function and income and used Taguchi quadratic function. Shokri and Walid (2011) presented a loss model to maximize profit function to obtain process mean for continuous production systems.

In the current research, similar to Bowling et al. (2004), the flow of a discrete production process is modeled based on absorbing Markov chain. In other words, in this process, all items do not reach the finished stage due to scrapping and reworking hence a stochastic process of a type called absorbing Markov chain will be adopted. The data required for such a model are (i) the probability of which an item goes from one stage of production to the next and (ii) the probability of reworking and scrapping items at various stages. At every stage of production, the item is inspected; if it does not conform to its specifications, it is either scrapped or reworked. The reworked item will be inspected again. We have added the cycle time of production in profit objective function. The cycle time is the time between productions of two successive items, which is computed based on the time of bottle-neck station. After inspecting each item, we use rework loops for reworking. Each item is inspected and if it is not within the specifications limits, item immediately is reworking or scrapping. Similar models have been presented by Fallahnezhad and Niaki (2010) and Fallahnezhad and Hosseininasab (2012).

We first present the required notations in section 2. The model development comes next in section 3. The numerical