An integrated optimization of quality control chart parameters and preventive maintenance using Markov chain

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A B S T R A C T

Manufacturing costs are reduced significantly with the integrated optimization of preventive maintenance and quality control. In this paper, a new mixed integer non-linear programming model is presented. This model determines the optimal preventive maintenance interval and the optimal parameters of the $(\bar{X})$ control chart, including the sampling interval and the sample size and the control limit. The production system is considered in the form of a continuous time Markov chain. Formulation of the production process of a machine in the form of a continuous time Markov chain is a breakthrough in the integrated modeling of repair and quality. The goal is to reduce costs per unit time. It is assumed that preventive maintenance can be carried out at several levels either perfect or imperfect. The duration of corrective and preventive maintenance is not negligible. Considering the length of time for maintenance, this model is closer to the real production environment. A numerical example is used to illustrate this new model. Sensitivity analysis was performed to determine the effect of the model parameters on optimal decisions. This analysis further shows the relationship between preventive maintenance and statistical quality control as well as the performance of the new model.

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Integrirana optimizacija parametrov nadzornega grafikona kakovosti in preventivno vzdrževanje z Markovsko verigo

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POVZETEK

Z integrirano optimizacijo preventivnega vzdrževanja in nadzora kakovosti se stroški proizvodnje znatno zmanjšajo. V tem prispevku je predstavljen nov mešani celoštevilski model nelinearnega programiranja. Model določa optimalni interval preventivnega vzdrževanja in optimalne parametre ($\bar{X}$) nadzornega grafikona, vključno z intervalom vzorčenja in velikostjo vzorca ter mejo nadzora. Proizvodni sistem je obravnavan v obliki neprekinjene časovne verige Markov. Formulacija proizvodnega procesa določenega stroja v obliki neprekinjene verige Markov je preboj v integriranem modeliranju popravil in kakovosti. Cilj je zmanjšati stroške na enoto časa. Domneva se, da se lahko preventivno vzdrževanje izvaja na več ravneh, popolno ali nepopolno. Trajanje korektivnega in preventivnega vzdrževanja ni zanemarljivo. Glede na dolžino časa za vzdrževanje je predstavljeni model bližje dejanskemu proizvodnemu okolju. Za ponazoritev modela je uporabljen številčni primer. Za določitev vpliva parametrov modela na optimalne odločitve je bila izvedena analiza občutljivosti. Analiza prikazuje povezavo med preventivnim vzdrževanjem in statističnim nadzorom kakovosti ter uspešnostjo predstavljenega modela.