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An Integrated Taguchi-Simulation-DEA approach for Optimum Maintenance Policy and Planning

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Abstract— In this paper, a new approach for maintenance policy and planning problem is developed. First, maintenance activities are simulated by incorporating learning effects. Production and maintenance functions are estimated using historical data. Then, simulation is carried out for different scenarios which are combinations of periodic maintenance and different policies. Several outputs including machines and operators' availability, reliability, efficiency and queue length are computed. Since the problem is multi-criteria, data envelopment analysis (DEA) method is used to select the preferred policy. In order to show the applicability of the proposed approach the data for a series production line is used and different scenarios with different policies are investigated. Since many scenarios are needed to be simulated, Taguchi orthogonal array design is used to reduce the number of scenarios. The proposed approach of this study would help managers to identify the preferred strategy considering and investigating various parameters and policies. This is the first study that introduces an integrated multi-criteria approach for optimum maintenance policy and planning.

Keywords- Maintenance Policy and Planning; Simulation; Data Envelopment Analysis (DEA); Optimization; Taguchi Orthogonal Array Design (TAOD); Learning Effects.

I.   INTRODUCTION

Maintenance involves planned (preventive) and unplanned actions carried out to retain a system at or restore it to an acceptable operating condition. Optimal maintenance policies aim to provide optimum system reliability and safety performance at the lowest possible maintenance costs. The objective of this study is modeling and planning of maintenance activities in an operational unit. It could be done with the precise analytical methods and mathematical models or simulations. Due to the complex nature of the various parameters affecting this case, an exact mathematical model for this problem does not exist, thus simulation is used for modelling the maintenance activities. Simulation is a valuable method, and widely used in various engineering problems. According to this method, the indexes and parameters of the maintenance are estimated by simulating the real process and the random behaviour of the system. Noting that in this problem, different objectives such as cost, availability, reliability and inventory level between different sectors are considered, to find the best solution which is the combination of several parameters, the methodology of data envelopment analysis (DEA) is used.

II.   LITERATURE REVIEW

In the past decades, maintenance, reliability and replacement problems have been investigated from different points of view. There are many models for reliability, maintenance, replacement and inspection, and recent researches have attempted to unify some of them [1, 2, 3, 4, 5].

Different methods and models have been used for maintenance activities planning. Mathematical modelling is widely used in this area [6, 7, 8]. Cassady and Kutanoglu [9] proposed an integrated model that coordinates preventive maintenance planning decisions with single-machine scheduling decisions so that the total expected weighted completion time of jobs is minimized. The machine of interest is subject to minimal repair upon failure, and can be renewed by preventive maintenance. They investigated the value of integrating production scheduling with preventive maintenance planning by conducting an extensive experimental study using small scheduling problems. Mijailovic [10] suggested a probabilistic method for the calculation of operation cost throughout a planning period and availability evaluation