Chapter 12
Mathematical Optimization Models for the Maintenance Policies in Production Systems

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ABSTRACT

This chapter initially presents a brief information about production systems. At these systems, different types of maintenance policies are developed to cope with wear out failures. Mainly used maintenance policies can be classified as corrective, preventive, and condition-based maintenance. In the corrective maintenance, repair or replacement is applied whenever components of the machine breakdown. In the preventive maintenance approach maintenance activities are applied to the critical components on a periodic basis. On the other hand, maintenance activities are applied whenever critical reliability level is reached or exceeded. These types of maintenance policies are modeled using mathematical modeling techniques such as linear programming, goal programming, dynamic programming, and simulation. A review of current literature about the mathematical models, the simulation-based optimization studies examining these maintenance policies are categorized and explained. Besides, the solution methodologies are discussed. Finally, the opportunities for future research are presented.

INTRODUCTION

Manufacturing environment and production technologies evolved rapidly in the past few decades. Proper maintenance has been drawing more and more attention to sustain the manufacturing systems' reliability, maintainability and availability. However, the maintenance cost can even reach 15 to 70% of the total expenditures (Madu 2000, Mobley 2002, Wang, Chu, & Mao, 2008). Although the maintenance was considered as a cost factor in the past, companies are more conscious about the importance of the maintenance activities and they noticed that these can add value to their business. Different decision

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tools can help companies to ensure a proper maintenance policy. In the literature, too many decision models exist. On the other hand, most of these models only remain in theory. Dekker (1996) focused on the maintenance models and the factors which prevent applications of them. The six reasons for the gap between theory and practice according to Dekker (1996) are that the maintenance models are difficult to understand; many papers are written only for math purposes, but the companies are not interested in publication; maintenance activities consist of many different aspects, optimization is not always necessary, and the models often focus on the wrong type of maintenance. Langberg (1988), Sherwin (2000), Li (2005) reviewed overall models for maintenance management. Wang (2002) provided a literature review, classified and compared maintenance policies taking into account both single-unit and multi-unit systems. Garg and Deshmukh (2006) reviewed the literature on maintenance management including the optimization models, maintenance techniques, scheduling, and information systems. Horenbeek et al. (2010) reviewed the literature on maintenance optimization models especially focusing on the optimization objectives used. Sharma and Yadava (2011), Ding and Kamaruddin (2015) reviewed the literature on maintenance management by considering the associated case studies and applications. Recently Alaswad and Xiang (2017) reviewed overall optimization models on Condition Based Maintenance (CBM) for stochastically deteriorating system. As one of the most important aspect of CBM, optimization criteria of CBM policies is also subjected to review in their research.

The specific objectives of this chapter are as follows:

1. To identify the characteristics of the production systems and the suitable maintenance operation strategies for them.
2. To consolidate the literature on maintenance management as much as possible with regard to both mathematical modelling and simulation based optimization.
3. To identify new trends in maintenance policies to be applied in the production systems.

PRODUCTION SYSTEMS

Production systems transform raw materials or semi-products into end-products. This transformation process typically uses resources such as material, energy, labor to make a change. A value adding activity is conducted in this process. The production systems are categorized according to different criterions. Traditional production systems can be categorized in terms of production process, type of product, amount of product produced, and implemented stock policy. On the other hand, modern production systems can be classified such as Just-in-Time Production, Cellular Manufacturing, Computer Integrated Manufacturing, Flexible Manufacturing, and Additive Manufacturing. Since the manufacturing and maintenance activities cannot be performed simultaneously, cutting-edge production systems require well planned maintenance activities, in order to increase the availability of the machines and lines.