Soft Computing
https://doi.org/10.1007/s00500-018-3291-x

METHODOLOGIES AND APPLICATION

Utilizing self-organization systems for modeling and managing risk based on maintenance and repair in petrochemical industries

F. Jaderi[1,2] · Zelina Z. Ibrahim[1] · Mehdi Nikoo[3] · Mohammad Nikoo[4]

Abstract
Maintenance is essential to ensure safe operation of equipment in normal conditions. Therefore, managers must identify the relative priorities and equipment maintenance requirements. Moreover, based on the results of equipment vulnerability assessments, maintenance programs can be developed and managed properly. There are different methods and techniques in the process of risk assessment and management and vulnerability of equipment. Seventy-six samples with different properties have been used in this study. Networks used in this study are self-organizing networks with constant weight, which include Kohonen networks. For this purpose, operation impact, operation flexibility, maintenance cost, impact of safety and environment and frequency parameters had been considered as input; and using this model, the risk level is calculated. Utilizing genetic algorithms, the structures of all self-organizing systems are optimized. In order to evaluate the accuracy of the model, we compare it with the fuzzy model, and the results indicate that self-organizing systems optimized with the genetic algorithm have higher ability, flexibility and accuracy than the fuzzy model in predicting risk.

Keywords Self-organization feature maps · Genetic algorithms · Fuzzy model · Risk management · Petrochemical industry

1 Introduction

Prevention of accidents and adverse events that may occur during industrial activities includes hazardous materials that require risk assessment. Minimizing losses due to equipment failure in any operation alongside maximizing production rates is among the objectives of all industries. Achieving this requires the establishment of rules related to maintenance (Zio 2009). Since the early 1980s onward, major advances have been made in the development of strategies related to maintenance (Khan and Haddara 2003). The types of maintenance were initially classified in two main categories of corrective and preventive in various references. So that preventive maintenance occurs before failure and to detect and prevent equipment failure, whereas corrective maintenance occurs after failure and to assess its consequences (Bashiri et al. 2011). However, in some references, these classifications have been listed in four categories of corrective maintenance, time-based preventive maintenance, conditional maintenance and predictive maintenance, and in some other references, even up to six models have been listed (Kumar and Maiti 2012). The main purpose of the maintenance process is, in fact having the right knowledge of failures and accidents in order to achieve a specific level of safety with the lowest possible cost (Arunraj and Maiti 2007).

Since the mid-1980s, the importance of choosing a suitable maintenance strategy in different areas was highly attended (Kumar and Maiti 2012). One of the new and comprehensive approaches in this field is Risk-Based Maintenance (RBM), which uses the concept of risk to prioritize

Communicated by V. Loia.

✉ F. Jaderi
jaderi@doe.ir; fereshtehjaderi@yahoo.com

Zelina Z. Ibrahim
zelina@upm.edu.my

Mehdi Nikoo
sazeh84@yahoo.com

Mohammad Nikoo
m.nikoo2014@gmail.com

1 Universiti Putra Malaysia, Faculty of Environmental Studies, 43400 UPM, Serdang, Malaysia

2 Department of Environment, Research Center of Environment and Sustainable Development, Tehran, Iran

3 Young Researchers and Elite Club, Islamic Azad University, Ahvaz Branch, Ahvaz, Iran

4 SAMA Technical and Vocational Training college, Islamic Azad University, Ahvaz Branch, Ahvaz, Iran

Published online: 12 June 2018