ABSTRACT

Reliability centred maintenance (RCM) is a corporate maintenance strategy, which provides a structured framework to analyse the functions and potential failures of an asset, focusing mainly on preserving its functions. It emphasizes on the principle of *'maximum availability vs. minimum cost'* of an asset. However, during its implementation, organizations are often confronted with different types of multiple-criteria based decision making situations such as prioritization of failure modes as per their risk levels, identifying their causes and effects (FMECA), diagnosing the faults at the earliest possible opportunity even with missing health indicators, and aiding the system with an appropriate maintenance strategy. The present research work is an attempt to address the aforementioned decision-making issues in a more abstract way and by illustrating the proposed solutions through a case study on a process plant gearbox.

Several integrated multi-criteria decision-making (MCDM) frameworks are proposed to overcome some major shortcomings of the traditional risk priority number (RPN) based failure modes ranking approach. Besides, the impacts of linguistic uncertainties are gradually minimized on the final risk ranking results by proposing the mathematical models of modified fuzzy multi-attributive ideal real comparative analysis (fuzzy MAIRCA), modified fuzzy measurement of alternative and ranking according to compromise solution (fuzzy MARCOS), extended interval type-2 fuzzy decision making trail and evaluation laboratory (IT2F-DEMATEL), IT2F-MAIRCA, IT2F-MARCOS, and modified IT2F-technique for order of preference by similarity to ideal solution (IT2F-TOPSIS). Apart from that, the causes and effects of different failure modes of the considered case study are identified from the triple bottom line (TBL) of sustainability with the aim of easing the implementation of sustainable manufacturing practices. The concept of half quadratic (HQ) minimization is utilized to address the issue of disparate risk ranking results by different MCDM methods through consensus index and trust level values.

Next, a decision support system based on case-based reasoning (CBR) methodology is developed for the fault diagnosis of the gearboxes at the earliest possible opportunity, considering the situation of incomplete information about multiple health indicators. Other than that, the developed system advises the engineers with the best possible maintenance tasks which are required to be performed after fault diagnosis.

Finally, a hybrid artificial intelligence-based framework is proposed for choosing the optimal maintenance strategy after identifying the key performance indicators for sustainability-based

maintenance strategy selection problems. This framework is developed to overcome the drawbacks of the principles of the MCDM methods by exploiting the advantages of both CBR and expert systems (ES). The outcomes of this research have culminated in the publications of four international refereed journal papers, one international conference paper and one book chapter. Another book chapter has also been communicated recently.

Keywords

Maintenance Decision Making, Multi-Criteria Decision Making, Fault Diagnosis, Case-Based Reasoning, Artificial Intelligence, Fuzzy Sets, Expert Systems, Machine Learning.