

A Fermatean Fuzzy MAIRCA Approach for Maintenance Strategy Selection of Process Plant Gearbox Using Sustainability Criteria

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Abstract : Due to strict regulations from government to enhance the possibilities of sustainability practices in industries, and noting the advances in sustainable manufacturing practices, it is necessary that the associated processes are also sustainable. Maintenance of large scale and complex machines is a pivotal task to maintain the uninterrupted flow of manufacturing processes. Appropriate maintenance practices can prolong the lifetime of machines, and prevent associated breakdowns, which subsequently reduces different cost heads. Selection of the best maintenance strategies for such machines are considered as a burdensome task, as they require the consideration of multiple technical criteria, complex mathematical calculations, previous fault data, maintenance records, etc. In the era of the fourth industrial revolution, organizations are rapidly changing their way of business, and they are giving their utmost importance to sensor technologies, artificial intelligence, data analytics, automations, etc. In this work, the effectiveness of several maintenance strategies (e.g., preventive, failure-based, reliability centered, condition based, total productive maintenance, etc.) related to a large scale and complex gearbox, operating in a steel processing plant is evaluated in terms of economic, social, environmental and technical criteria. As it is not possible to obtain/describe some criteria by exact numerical values, these criteria are evaluated linguistically by cross-functional experts. Fuzzy sets are potential soft-computing technique, which has been useful to deal with linguistic data and to provide inferences in many complex situations. To prioritize different maintenance practices based on the identified sustainable criteria, multi-criteria decision making (MCDM) approaches can be considered as potential tools. Multi-Attributive Ideal Real Comparative Analysis (MAIRCA) is a recent addition in the MCDM family and has proven its superiority over some well-known MCDM approaches, like TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and ELECTRE (ELimination Et Choix Traduisant la REalité). It has a simple but robust mathematical approach, which is easy to comprehend. On the other side, due to some inherent drawbacks of Intuitionistic Fuzzy Sets (IFS) and Pythagorean Fuzzy Sets (PFS), recently, the use of Fermatean Fuzzy Sets (FFSs) has been proposed. In this work, we propose the novel concept of FF-MAIRCA. We obtain the weights of the criteria by experts' evaluation and use them to prioritize the different maintenance practices according to their suitability by FF-MAIRCA approach. Finally, a sensitivity analysis is carried out to highlight the robustness of the approach.

Keywords : Fermatean fuzzy sets, Fermatean fuzzy MAIRCA, maintenance strategy selection, sustainable manufacturing, MCDM

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