INTERVAL-VALUED INTUITIONISTIC FUZZY TOPSIS-BASED MODEL FOR TROUBLESHOOTING MARINE DIESEL ENGINE AUXILIARY SYSTEM

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SUMMARY

In this paper, we present an interval-valued Intuitionistic Fuzzy TOPSIS model, which is based on an improved score function for detecting failure in a marine diesel engine auxiliary system, using groups of experts’ opinions to detect the root cause of failure in the engine system and the area most affected by failures in the diesel engine. The improved score function has been used for the computation of the separation measures from the intuitionistic fuzzy positive ideal solution (IFPIS) and intuitionistic fuzzy negative ideal solution (IFNIS) of alternatives while the criteria weight have been determined using an intuitionistic fuzzy entropy. The study is aimed at providing an alternative method for the identification and analysis of failure modes in engine systems. The results from the study show that although detection of failures in Engines is quite difficult to identify due to the dependency of the engine systems on each other, however using intuitionistic fuzzy multi-criteria decision-making method the faults/failure can easily be diagnosed.

ABBREVIATIONS

FTA Fault Tree Analysis
FMEA Failure Mode and Effect Analysis
IVIFS Interval-valued Intuitionistic Fuzzy set
IVIFSS Interval-valued Intuitionistic Fuzzy sets
IFE Intuitionistic Fuzzy entropy
TOPSIS Technique for Order Preference by Similarity to the Ideal Solution

1. INTRODUCTION

The main aim of every maintenance strategy is to prevent the high cost of productions and maintenance risks due to faults in rotating machines and systems (Zuber & Bajri 2016). Since many of the modern machines and equipment are required to run under increased turbulent conditions and in some cases under high uncertainty (Kettunen 2006). It is important, therefore, that the health of the machines and systems are regularly monitored, checked and troubleshoot for failure. According to Zuber & Bajri (2016), the implementation of condition-based maintenance strategy for monitoring the health of machines and systems requires the acquisition and trending of the physical parameter that is found to be sensitive to the machine degradation and failure.

In identifying the physical parameters and failure in machines systems, several different failure detection measures such as pressure, heating, and flow rate sensors, vibration analysis, noise measurement, motor current signature analysis, wear particle analysis, ultrasound measurements devices and infrared thermography are available and rottenly used to detect and monitor failure in machines and systems. However according to Balin et al. (2014), even if the values and warning indicators from the failure detection measures are taken into account, detection of the exact failed component(s) or system(s) in the machines is still quite difficult to determine, due to the dependency of the machine systems on each other.

Other analytical methods for identifying and evaluating potential machine failure include the Fault Tree Analysis (FTA) method and the Failure Mode and Effect Analysis (FMEA) method. Also, in applying these methods, so many drawbacks have been reported in the literature which includes; the difficulty to precisely and accurately determines the probability of failure event when using the FMEA technique (Mohammadi and Tavakolan 2013; Xie 2013). The fuzziness and hesitation of the experts’ subjective assessments which are not accounted for in the FMEA and FTA technique (Zhao et al. 2016) and the limitation of the methods when it comes to design errors, human factors implications, flawed requirements and component interaction accidents (Keizer et al. 2005; Liu et al. 2014; Martínez 2015).

In handling these issues, several alternative methods and approaches have been presented by different authors in the literature. Among them we can mention, Sharma et al. (2005), who integrated fuzzy logic and expert database to evaluate hydraulic system safety and reliability while conducting failure mode and effect analysis (FMEA). Zuber & Bajri (2016), propose an artificial neural network and vibration analysis for automated roller element bearings faults identification, where the vibration features were used as the inputs for the controlled artificial neural network. Shaghaghi and Rezaie (2012) applied a generalized mixture operator to evaluate and aggregate risk priorities of failure modes in an LGS gas type circuit breaker. An expert failure detection system was employed by Cebi et al. (2009) to assist shipboard personnel in predicting and overcoming failures in operational ship auxiliary machinery via a PROLOG programming language. They developed corrective action tables to demonstrate what to do in the event of an emergency based on some identified failure types. Kangavari et al. (2015), uses the FMEA technique