

Although these efforts have eliminated the shortcomings of the conventional FMEA to some extent, a problem still exist. In the majority of the MCDM methods including those that are used to improve the applicability of FMEA, the weight of criteria are determined only based on the subjective judgments of decision makers. While it is convenient for the experts to represent their judgments in terms of the linguistic variables, though there are some limitations for expressing their opinions in this manner. Subjective judgments often are presented by linguistic variables in terms of the fuzzy numbers. Although the fuzzy numbers could handle the fuzziness of the experts' information, they could not reflect the partial reliability exists in the experts' judgments ([Kang et al., 2012](#)). As an example, one may express his opinion about the severity of a failure mode as "very high" or "catastrophic" but he may hesitate about his opinion. In other words, it may be better to represents it as "catastrophic, with high degree of reliability". To deal with this limitation we used the Z-number. The concept of the Z-number was proposed by L. A. Zadeh ([Zadeh, 2011](#)). A Z-number is an ordered pair $Z = (A, R)$; where A is an imprecise restriction on values of X and R is an imprecise estimation of reliability of A ([Kang et al., 2012](#)). Furthermore, the subjective fixed weight methods could deviate the indexes' weights because of subjective factors. While subjective methods specify weights only based on the preference or opinions of decision makers, objective methods employ mathematical models (i.e. entropy method or multiple objective programming) to automatically avoid the use of decision makers' preferences. Objective weighting approach is particularly appropriate for situations where consistent subjective weights could not be acquired ([Deng et al., 2000](#)).

Regarding to the abovementioned limitations, this study aims at the development of a framework for evaluation of the equipment failure modes by the FMEA method applying the two-facet approach (subjective-objective ranking) in fuzzy environment. In this work, in one hand we are using the Z-numbers to obtain the expert's opinions (subjective weights) about the importance of the risk factors, and on the other hands we are using the entropy concept to consider the objective weighting of the failure modes. The contribution of this work is the application of the Z-numbers to handle the partial reliability associated with the expert's opinions when they want to express their judgments about the FMEA risk factors.

To the best of our knowledge, this work is the first study that uses the objective-subjective weighting method by Z-number combined with the VIKOR approach for ranking of the failure modes in a geothermal power plant (GPP).