Risk Assessment using Fuzzy FMEA (Case Study: Tehran Subway Tunneling Operations)

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Abstract

Background/Objective: FMEA is an appropriate tool for identification, evaluation and effective management of risks in a project. For this purpose, the proposed work tried to assess the risks by using a fuzzy FMEA. Methods: On the one hand, the parameter input of the method (frequency, occurrence, severity and detection of a failure mode) is determined by experts and can be found in difficult due to several uncertainties as well as qualitative and subjective judgments. Results: On the other hand, tunnel construction projects are found among the riskiest projects due to lack of sufficient knowledge of land characteristics, surrounding conditions, diversity of activities, expansion, equipment density, human factors and uncertainties related to their design and implementation. Failure in identification, evaluation, timely and effective management of these projects can increase the duration and cost of implementing these projects. In this study, fuzzy logic (using two computational approaches) is used as a complementary tool to perform a consistent and logical analysis. Conclusion: The results showed that Fuzzy FMEA is more flexible and realistic compared with the traditional FMEA method.

Keywords: Fuzzy Logic, FMEA, Risk Assessment, Tunneling

1. Introduction

FMEA (failure mode and effects analysis) is an important technique for identification and radical analysis of potential failure modes of a product or process, and perhaps no other risk analysis technique can be an alternative to FMEA. This technique can also be used to improve processes and enhance product quality at each stage of production. In this technique, failure modes are analyzed by an expert team and three parameters of severity, occurrence and detection are considered for each failure mode. These three parameters usually have values between 1 and 10 and their multiplication gives a value between 1 and 1000, which is known as RPN (risk priority number). Different failure modes are prioritized in terms of severity score as well as RPN. This method is based on human thinking and feeling and so the works face a vague imprecise concept and an accurate quantitative value cannot be considered for the triple parameters. In other words, can assign a value between 1 to 10 to each of the factors influencing the risk is a difficult task for the relevant multi-disciplinary team and causes considerable discrepancy in calculations.

Given the need to make a final decision concerning the causes of non-compliance in analysis methods of failure modes and their consequences as well as exposure to inaccurate parameters, fuzzy theory seems to be capable of mathematical formulation of vague and inaccurate variables needed to calculate the risk priority number to enable prioritization of ultimate causes of nonconformities. Since Fuzzy FMEA is a relatively new subject, few studies have been done in this field, the most important of which are listed in Table 1.

Tunnel construction projects are among the riskiest projects given the lack of sufficient awareness of land features, surrounding circumstances, diversity of activities, expansion, equipment density, human factors as well as uncertainties associated with their design and