Sensitivity Analysis for Fuzzy Logic-Based Life-Cycle Cost Analysis Approach

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Abstract:

Life cycle cost analysis (LCCA) is a key component in the transportation asset management process. Both deterministic and probabilistic LCCA approaches have been used by transportation agencies. Probabilistic methods allow decision makers to evaluate the risk of an investment utilizing uncertain input variables, assumptions, or estimates. However, if the uncertainty in the input is of an ambiguous rather than random nature, soft computing techniques might be more appropriate than the probabilistic methods.

This paper summarizes research aimed at comprehensively evaluating the sensitivity of a prototype fuzzy logic-based LCCA model to inputs, fuzzy variable membership functions, and fuzzy logic inference rules. The motivation of the research was to help design a practical setup process for fuzzy logic-based LCCA models to support transportation asset management decisions. The paper will highlight the results of the sensitivity analysis and provide recommendations on how to set up a practical fuzzy logic-based LCCA model.

The prototype fuzzy logic-based LCCA model was originally designed for pavement projects but with consideration of future expansion for the use with other transportation assets. The model's input parameters include both structural and functional conditions of transportation assets. The outputs of the fuzzy logic system are recommended maintenance and rehabilitation (M&R) strategies. These strategies comprise selected treatment and recommended timing for those treatments. Agency costs over the life of the asset are estimated and discounted to current values. The sensitivity analysis specifically focused on the following questions:

(1) How do variations in the performance models affect the predicted life-cycle costs and recommendations?

(2) What is the effect of changes in the membership functions of fuzzy variables?

(3) How sensitive are the results to changes in the inference rules used in the fuzzy logic system.