

Fuzzy Reliability Analysis of the Washing System in a Paper Plant for Components with Different Membership Function

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Abstract: The washing system in paper plant is a complex engineering system that needs to develop effective maintenance programs for enhancing its performance via reliability analysis. The reliability analysis of these systems requires precise numerical data which may be very difficult to obtain in desired crisp form due to uncertainty. In general, triangular fuzzy number are used to quantify data uncertainty and fuzzy arithmetic operations are employed which give wide range of prediction for each computed reliability index due to accumulating phenomenon of fuzziness. To reduce the range of prediction of system reliability and fasten the computation process, this paper presents T_x (weakest t-norm) based generalized fuzzy lambda–tau technique in which different fuzzy membership functions are used to quantify uncertainty while α -cut and T_x based approximate fuzzy arithmetic operations are employed for computation. The advantage of this technique is that this technique uses different fuzzy numbers as input to quantify different types of uncertainties and gives fuzzy reliability indices of the system having shape preserving characteristic, fitter decision values with compressed range of prediction under vague environment which is better for strong decision making to improve system performance. To show the effectiveness of the presented approach, computed results have been compared with results obtained from four other existing approaches. Moreover, this paper uses extended Tanaka et al. (Komal in Ocean Eng 155:278–294, 2018b) approach to rank the critical components of the system. Sensitivity, long run reliability and availability analyses have also been conducted to analyse the impact of variation of different reliability indices and time respectively on system performance.

Keywords: Fuzzy reliability; Fault tree; Fuzzy membership function; Lambda–tau expressions; α -Cut; Weakest t-norm (T_x)