Reliability Analysis of a Multi-Subsystem Industrial System with Dependent Repair using Gumbel-Hougaard Copula and Supplementary Variable Technique

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Abstract:

This paper presents a novel reliability analysis of a complex industrial system consisting of six interconnected subsystems: Spinning/Twisting, Weaving/Knitting, Bleaching, Dyeing, Printing, and Finishing. Failures within the system follow an exponential distribution. The repair process is distinguished into two types: a general distribution for independent repairs and a complex repair involving two dependent sub-processes whose durations are modelled by the Gumbel-Hougaard family copula. For the Spinning/Twisting subsystem, at least 'k' out of 'n' units must be operational, and for the Weaving/Knitting subsystem, at least 'k' out of 'm' units must be operational. The system's behaviour is analysed by employing the supplementary variable technique and Laplace transforms to derive measures of reliability and availability. Various reliability metrics are computed for different failure rates and repair scenarios, highlighting the significant impact of repair dependencies and subsystem configurations. Maple program generates numerical results and graphical images to show the theoretical conclusions.