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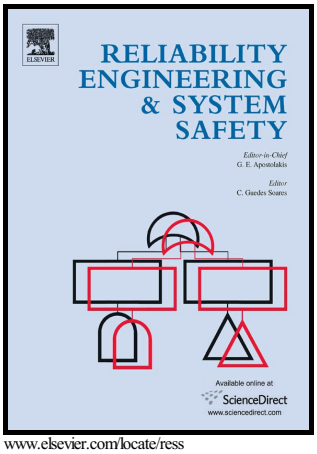


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# Reliability Assessment of Competing Risks with Generalized Mixed Shock Models

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## Abstract

This paper investigates reliability modeling for systems subject to dependent competing risks considering the impact from a new generalized mixed shock model. Two dependent competing risks are soft failure due to a degradation process, and hard failure due to random shocks. The shock process contains fatal shocks that can cause hard failure instantaneously, and nonfatal shocks that impact the system in three different ways: 1) damaging the unit by immediately increasing the degradation level, 2) speeding up the deterioration by accelerating the degradation rate, and 3) weakening the unit strength by reducing the hard failure threshold. While the first impact from nonfatal shocks comes from each individual shock, the other two impacts are realized when the condition for a new generalized mixed shock model is satisfied. Unlike most existing mixed shock models that consider a combination of two shock patterns, our new generalized mixed shock model includes three classic shock patterns. According to the proposed generalized mixed shock model, the degradation rate and the hard failure threshold can simultaneously shift multiple times, whenever the condition for one of these three shock patterns is satisfied. An example using micro-electro-mechanical systems devices illustrates the effectiveness of the proposed approach with sensitivity analysis.

**Keywords:** Dependent competing risks, changing degradation rate, shifting hard failure threshold, generalized mixed shock model