RELIABILITY TRADE-SPACE EXPLORATION MODELLING FOR SATELLITE ANOMALIES USING EXPONENTIAL DISTRIBUTION

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Abstract The delivery of critical communication, navigation, and earth observation services relies on the reliability of satellite subsystems. However, satellites can be affected by radiation and temperature extremes. Anomalies can cause the system to fail and stop working. This research aims to fix the lack of a high-performance reliability model compared to previous work by integrating trade-space exploration (TSE) techniques and an exponential reliability mathematical model. Data from the Seradata database was analyzed using MATLAB to check for issues with antennas, transponders, amplifiers, and batteries as the prominent components of satellite anomalies. Studies were

carried out by building parametric (Weibull, Exponential, and Poisson) and non-parametric (Kaplan-Meier and Monte Carlo Simulation) models, and all were assessed. Results were measured using Root Mean Square Error (RMSE), revealing that the Exponential model performed most accurately compared to other mathematical models. After that, the TSE framework was applied to examine the Design Dependent Parameters (DDPs): reliability, design life, and system performance. The results conclude that the newly developed exponential-based reliability TSE model shows a promising outcome, with RMSE values of 34.2, 10.2, 19.6, and 19.9 compared to Nadirah's model and Shazana's model, which have RMSE values of 16.1, 49.7, 28.2, and 27.6 for antenna, transponder, amplifier, and battery, respectively.

Keywords **Author Keywords:** Reliability; Trade-Space Exploration; Exponential; DDPs; RMSE; Satellite Anomalies

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