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TRADE-SPACE EXPLORATION COMPARISON OF PARAMETRIC COST MODELS FOR SATELLITE ANOMALIES WITH RMSE AND RRMSE

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Abstract	Satellites are essential for modern communication, navigation, and Earth observation, but their operation in the harsh space environment makes them vulnerable to anomalies and failures, resulting in significant financial losses. This research investigates the relationship between the design life of satellite subsystems and the cost of anomalies, using data from the Seradata database. Three statistical models, Exponential, Weibull, and Poisson distributions, were applied to cost data for four critical subsystems: antenna, payload, power system, and attitude

control. Each model was fitted using one-variable (cost only) and two variable approaches (design life and cost) to evaluate subsystems' behaviour independently and in combination. The performance of each model was assessed using the Root Mean Square Error (RMSE) and the Relative RMSE (RRMSE). Among all models, the Exponential distribution consistently produced the best results. For instance, the payload subsystem achieved the lowest RMSE and RRMSE of 115.73 and 41.66% in the two-variable case. Similarly, the attitude control subsystem showed strong performance with an RMSE of 110.57 and RRMSE of 40.59%. In contrast, the Poisson distribution yielded the highest errors across most subsystems, with the antenna subsystem reaching an RMSE of 489.87 and RRMSE of 102.65% in the two-variable fitting. The Weibull model demonstrated mixed performance, performing moderately for the payload subsystem (RMSE 186.21, RRMSE 67.03%), but poorly for the power system and antenna subsystems, particularly when two variables were used.

Keywords

Author Keywords: Parametric cost mathematical models; satellite anomalies; trade-space exploration; Exponential; Weibull; Poisson; RMSE; RRMSE

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