



Bayesian Hierarchical Model for Measuring System Reliability in Rwandan Manufacturing Plants: A Methodological Evaluation

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Abstract

Manufacturing plants in Rwanda are increasingly adopting advanced management techniques to enhance productivity and efficiency. However, understanding system reliability remains a critical but often overlooked aspect of operations. A mixed-methods approach was employed, integrating both qualitative interviews with managers and quantitative data analysis using a Bayesian hierarchical model to estimate system reliability parameters such as mean time between failures (MTBF). The analysis revealed that the MTBF for critical manufacturing processes in Rwandan plants was significantly higher than expected under standard models, indicating improved reliability. This study supports the use of Bayesian hierarchical modelling for enhancing system reliability measurement in industrial settings, offering a robust framework for future interventions. Manufacturing managers should consider implementing this model to better understand and optimise their systems' performance. Bayesian Hierarchical Model, System Reliability, Manufacturing Plants, Rwanda The empirical specification follows $Y = \beta_{0+\beta}^{-1} p X + \text{varepsilon}$, and inference is reported with uncertainty-aware statistical criteria.

Keywords: *African agriculture, Bayesian statistics, hierarchical modelling, intervention studies, precision farming, randomized controlled trials, yield assessment*

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