



# Bayesian Hierarchical Model for Measuring System Reliability in Process-Control Systems: A Methodological Evaluation in Tanzania

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## Abstract

Process-control systems in Tanzania are critical for maintaining production efficiency across various industries. A mixed-methods approach was employed, combining quantitative data analysis with qualitative feedback from Tanzanian industrial practitioners. The application of a Bayesian hierarchical model revealed that system reliability could be improved by at least 15% through targeted interventions in critical components. Bayesian hierarchical models offer a robust method for enhancing the reliability and efficiency of process-control systems, providing tangible benefits to Tanzanian industries. Further research should explore the scalability of these findings across different industry sectors and geographic regions. The maintenance outcome was modelled as  $Y_i = \beta_0 + \beta_1 X_i + u_i + \epsilon_i$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** *Tanzania, Bayesian hierarchical model, reliability assessment, process-control systems, mixed-methods approach, methodological evaluation, statistical inference*

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