



Bayesian Hierarchical Model Evaluation of Process-Control Systems in Tanzanian Risk Reduction Studies

Kamuntu Mbeweala¹, Mwakalunga Nganga²

¹ Department of Mechanical Engineering, Tanzania Commission for Science and Technology (COSTECH)

² Tanzania Commission for Science and Technology (COSTECH)

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Correspondence: kmbeweala@aol.com

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Author notes

Kamuntu Mbeweala is affiliated with Department of Mechanical Engineering, Tanzania Commission for Science and Technology (COSTECH) and focuses on Engineering research in Africa.

Mwakalunga Nganga is affiliated with Tanzania Commission for Science and Technology (COSTECH) and focuses on Engineering research in Africa.

Abstract

Bayesian hierarchical models are increasingly being used to evaluate process-control systems in various fields, including risk reduction studies in Tanzania. A Bayesian hierarchical model was developed to analyse process-control systems data from multiple sites in Tanzania. The model accounts for spatial and temporal variations, incorporating prior knowledge about system performance across regions. Uncertainty quantification is achieved through credible intervals derived from Markov Chain Monte Carlo (MCMC) simulations. The Bayesian hierarchical model showed a significant reduction in risk estimation errors by up to 30% compared to conventional models when applied to data from two study sites in Tanzania, highlighting the importance of spatial and temporal dependencies in risk assessment. The findings underscore the potential of Bayesian hierarchical models for enhancing the precision of risk reduction measurements in Tanzanian process-control systems. Future research should validate these results across more regions to ensure generalizability and reliability. Additionally, further exploration into model sensitivity to varying data sets is recommended. The maintenance outcome was modelled as $Y = \beta_0 + \beta_1 X + u_i + v_{\epsilon}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Bayesian statistics, Hierarchical modelling, Process control, Risk assessment, Tanzania, Statistical inference, Bayesian methods*

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