Bayesian Hierarchical Model for Measuring System Reliability in Senegal's Water Treatment Facilities Systems

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Abstract

Water treatment facilities in Senegal face challenges related to system reliability, necessitating a robust methodological approach. A Bayesian hierarchical model was applied to analyse data from different Senegalese water treatment facilities. The model accounts for variability in facility performance by incorporating site-specific parameters into the overall reliability assessment. The analysis revealed significant differences in system reliability among various sites, with some facilities exhibiting a 20% higher effectiveness than others. The Bayesian hierarchical model provided insights into systematic variations affecting water treatment efficacy, offering tailored recommendations for facility upgrades and maintenance strategies. Facility managers should prioritise upgrading older systems identified as less reliable. Additionally, cross-site comparisons can inform regional policy on resource allocation for improved water supply. The maintenance outcome was modelled as $Y\{\} = beta\,0 + beta\,1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Bayesian statistics, hierarchical modelling, reliability engineering, Markov Chain Monte Carlo (MCMC), geographic information systems (GIS), stochastic processes, spatial analysis*

ABSTRACT-ONLY PUBLICATION

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