



Bayesian Hierarchical Model for Assessing Power-Distribution Equipment Reliability in Nigerian Systems

Ifeyinfa Adekoya¹, Odarumeh Emmanuel², Balogun Olayiwola^{3,4}

¹ University of Ilorin

² University of Jos

³ University of Ibadan

⁴ Department of Civil Engineering, University of Ilorin

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Correspondence: iadekoya@outlook.com

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Author notes

*Ifeyinfa Adekoya is affiliated with University of Ilorin and focuses on Engineering research in Africa.
Odarumeh Emmanuel is affiliated with University of Jos and focuses on Engineering research in Africa.
Balogun Olayiwola is affiliated with University of Ibadan and focuses on Engineering research in Africa.*

Abstract

Power distribution equipment (PDE) systems in Nigeria are critical for ensuring reliable electricity supply to residential, commercial, and industrial sectors. However, these systems often face reliability challenges due to factors such as poor maintenance practices, inadequate inspection schedules, and the use of substandard materials. A Bayesian hierarchical model was employed to analyse data collected from field inspections and maintenance records of PDE systems across different regions in Nigeria. This approach allows for the estimation of both fixed effects (system-specific parameters) and random effects (region-specific variability). The analysis revealed significant regional variations in system reliability, with urban areas showing higher reliability compared to rural settings. The Bayesian hierarchical model provided a robust framework for understanding PDE system performance across Nigeria's diverse regions. The identified regional disparities highlight the need for targeted interventions tailored to specific geographical conditions. Based on the findings, recommendations include increasing inspection and maintenance schedules in rural areas, improving training programmes for maintenance personnel, and promoting the use of high-quality materials in equipment procurement. Bayesian hierarchical model, power distribution equipment, reliability assessment, Nigeria, regional disparities 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: Nigerian, Bayesian, Hierarchical, Model, Reliability, Evaluation, Methodology

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