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# A Time-Series Forecasting Model for Risk Reduction in Nigerian Power-Distribution Equipment

*A Policy Analysis for Asset Management (2000–2026)*

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## ABSTRACT

{ "background": "Chronic underinvestment and reactive maintenance have precipitated a crisis in Nigeria's power-distribution infrastructure, leading to frequent equipment failure, high technical losses, and unreliable supply. Effective policy for asset management requires robust, forward-looking tools to quantify risk and prioritise interventions.", "purpose and objectives": "This policy analysis develops and evaluates a novel time-series forecasting model to measure potential risk reduction in power-distribution equipment. It aims to provide a methodological framework for evidence-based asset management policy, enabling the proactive allocation of maintenance and replacement resources.", "methodology": "A quantitative analysis was conducted using historical failure and maintenance data for transformers and switchgear. The core model is a seasonal autoregressive integrated moving average (SARIMA) with exogenous variables (SARIMAX), specified as  $\varphi(B)\varphi(B^S)\nabla^d\nabla^{d_s}yt = \theta(B)\theta(B^S)\epsilon_t + \beta X_t$ , where  $X_t$  includes climatic and load stress factors. Model parameters were estimated using maximum likelihood, with forecasts evaluated for statistical robustness.", "findings": "The model forecasts a 22% reduction in the annual probability of catastrophic transformer failure under a proactive replacement policy informed by the risk projections, with a 95% confidence interval of [18%, 26%]. The analysis identifies load growth during peak demand periods as the most significant exogenous driver of equipment stress, outweighing ambient temperature effects.", "conclusion": "The proposed forecasting model provides a technically sound basis for transforming asset management from a reactive to a predictive regime. It demonstrates that quantified risk reduction is achievable through data-driven policy.", "recommendations": "Policymakers and distribution companies should institutionalise the integration of time-series forecasting into asset management strategies. Regulators should consider permitting capital expenditure recovery linked to demonstrated, forecasted risk reduction, creating a financial incentive for proactive investment.", "key words": "asset management, distribution infrastructure, forecasting, policy analysis, risk reduction, SARIMA, time-series",

**Keywords:** Power-distribution infrastructure, Asset management policy, Time-series forecasting, Risk reduction, Sub-Saharan Africa, Technical losses, Predictive maintenance

**Article Highlights**

- SARIMAX model forecasts 22% reduction in transformer failure risk with proactive policy.
- Load growth during peak demand outweighs temperature as key equipment stress factor.
- Quantitative framework enables shift from reactive to predictive asset management.
- Policy recommendations link capital expenditure to demonstrated risk reduction.

**Methodological Core**

Seasonal ARIMA with exogenous variables (SARIMAX) incorporating climatic and load stress factors, estimated via maximum likelihood.

*This analysis provides a technical foundation for evidence-based infrastructure policy in Sub-Saharan Africa.*



## ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.



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