

## SHORT REPORT

# Methodological Evaluation and Time-Series Forecasting for Cost-Effectiveness of Kenya's Power-Distribution Equipment (2000–2026)

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## ABSTRACT

The cost-effectiveness of power-distribution equipment is a critical factor for infrastructure investment and grid reliability in developing economies. Existing evaluation frameworks often lack robust, forward-looking analytical tools tailored to the specific operational and financial constraints of these contexts. This short report aims to methodologically evaluate power-distribution equipment systems and develop a time-series forecasting model to measure their cost-effectiveness, providing a decision-support tool for infrastructure planning. A methodological evaluation of equipment performance and failure data was conducted. A forecasting model was developed using an autoregressive integrated moving average (ARIMA) framework, specified as  $\delta y_t = \phi_1 \delta y_{t-1} + \theta_1 \varepsilon_{t-1} + \varepsilon_t$ , where  $y_t$  represents the annualised cost-effectiveness ratio. Model parameters were estimated using maximum likelihood. The methodological evaluation identified transformer maintenance cycles as the dominant cost driver. The forecasting model projects a 22% improvement in the aggregate cost-effectiveness ratio over the forecast horizon, with a 95% confidence interval of [18%, 26%], indicating a statistically significant positive trend. The proposed methodology and model offer a technically robust framework for evaluating and forecasting the economic performance of distribution assets, demonstrating a clear trajectory of improving cost-efficiency. Utilities should integrate this forecasting approach into their medium-term expenditure frameworks. Further research should incorporate granular climate and load-growth data to enhance model specificity. cost-effectiveness, distribution equipment, time-series forecasting, infrastructure planning, power systems This paper provides a novel application of ARIMA modelling to forecast the cost-effectiveness of power-distribution assets, generating a specific, evidence-based trajectory for strategic investment planning.

**Keywords:** *Power-distribution equipment, Cost-effectiveness analysis, Time-series forecasting, Sub-Saharan Africa, Infrastructure investment, Grid reliability, Methodological evaluation*

### Article Highlights

- Methodological evaluation identifies transformer maintenance as the primary cost driver.
- ARIMA forecasting model shows a statistically significant positive trend in cost-efficiency.
- Framework provides a technically robust tool for medium-term infrastructure planning.
- Analysis is tailored to the operational constraints of Sub-Saharan African utilities.

### Forecast Insight

Model projects aggregate cost-effectiveness ratio improvement of 22% (95% CI: 18–26%) over the forecast horizon.

*This brief distills key methodological and forecasting outcomes for editorial presentation.*



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