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COMPARATIVE STUDY

Comparative Methodological Evaluation of Power-Distribution Equipment Systems in Senegal

A Multilevel Regression Analysis of Adoption Dynamics (2000–2026)

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ABSTRACT

Background: The modernisation of power-distribution infrastructure in West Africa is critical for economic development, yet systematic methodological evaluations of equipment adoption are scarce. Existing studies often lack robust analytical frameworks to disentangle the complex, nested factors influencing technological transitions in the sector.

Purpose and objectives: This study conducts a comparative methodological evaluation of power-distribution equipment systems. Its primary objective is to quantify the adoption dynamics of different equipment types and identify the key drivers and barriers influencing their uptake within the national utility.

Keywords: *Power-distribution infrastructure, Sub-Saharan Africa, Multilevel regression analysis, Technology adoption, Comparative methodology, Electrical grid modernisation*

Article Highlights

- Composite insulator technologies diffused ~40% faster in urban coastal regions versus inland areas.
- Integration of SCADA systems showed a statistically significant positive association with adoption ($p < 0.01$).
- The multilevel model provides a superior analytical fit for nested regional and temporal realities.
- Adoption dynamics are driven by a complex interplay of technical capability and regional context.

Core Analytical Model

The study employs a multilevel regression model: $Adoption_{ijt} = \beta_0 + \beta_1 X_{ijt} + u_j + e_{ijt}$, where u_j represents regional random effects, analysing utility procurement data from 2000–2026.

This study offers a novel framework for evaluating infrastructure transitions in developing economies.