



# Multilevel Regression Analysis to Evaluate Adoption Rates of Water Treatment Facilities in Senegal: An Engineering Perspective

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### Abstract

This study addresses a current research gap in Engineering concerning Methodological evaluation of water treatment facilities systems in Senegal: multilevel regression analysis for measuring adoption rates in Senegal. The objective is to formulate a rigorous model, state verifiable assumptions, and derive results with direct analytical or practical implications. A mixed-methods design was used, combining survey and interview data collected over the study period. The results establish bounded error under perturbation, a convergent estimation process under stated assumptions, and a stable link between the proposed metric and observed outcomes. The findings provide a reproducible analytical basis for subsequent theoretical and applied extensions. Stakeholders should prioritise inclusive, locally grounded strategies and improve data transparency. Methodological evaluation of water treatment facilities systems in Senegal: multilevel regression analysis for measuring adoption rates, Senegal, Africa, Engineering, original research This work contributes a formal specification, transparent assumptions, and mathematically interpretable claims. The maintenance outcome was modelled as  $Y_i = \beta_0 + \beta_1 X_i + u_i + \varepsilon_i$ , with robustness checked using heteroskedasticity-consistent errors.

**Keywords:** Sub-Saharan, Senegalese, multilevel, regression, evaluation, infrastructure, adoption

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