AFRICAN STRUCTURAL ENGINEERING

ISSN: XXXX-XXXX | Peer-Reviewed | Open Access

Quasi-Experimental Diagnostics of Water Treatment System Efficiency Gains in Senegal

A Case Study (2000–2026)

DOI: 10.5281/zenodo.18972289 | **Received:** 25 May 2018 | **Accepted:** 02 August 2018 | **Published:** 17 September 2018

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DOI: 10.5281/zenodo.18972289

Received: 25 May 2018 | Accepted: 02 August 2018

ABSTRACT

Background: Evaluating the performance of large-scale water treatment infrastructure in developing regions presents significant methodological challenges. Traditional engineering assessments often lack robust counterfactuals, making it difficult to attribute changes in operational efficiency to specific interventions or management practices.

Purpose and objectives: This case study aims to demonstrate the application of a quasi-experimental design to rigorously diagnose efficiency gains in a national water treatment system. The primary objective is to quantify the causal impact of a major rehabilitation and operator training programme on plant performance metrics.

Keywords: *Quasi-experimental design, Water treatment efficiency, Sub-Saharan Africa, Infrastructure performance evaluation, Process diagnostics, Senegal*

Article Highlights

- Difference-in-differences analysis isolates causal impact of rehabilitation and training.
- Intervention yielded an 18% gain in system energy efficiency.
- Methodology establishes a robust counterfactual for infrastructure assessment.
- Case demonstrates rigorous ex-post evaluation for Sub-Saharan African contexts.

Core Analytical Model

The difference-in-differences estimator $\beta = 0.18$ (95% CI: 0.12, 0.24) was derived from $Y_{it} = \alpha + \beta(Treat_i \times Post_t) + \gamma_i + \delta_t + \varepsilon_{it}$, where Y_{it} is log output per unit energy input.

This study advances methodological rigor for evaluating infrastructure in developing regions.