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A Quasi-Experimental Design for Cost-Effectiveness Diagnostics of Nigerian Water Treatment Systems (2000–2026)

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ABSTRACT

Background: Evaluating the cost-effectiveness of water treatment infrastructure in developing nations remains a significant challenge, often hindered by a lack of controlled experimental conditions and longitudinal operational data. Existing assessments frequently rely on cross-sectional data, which fail to account for temporal variations and confounding factors inherent in complex engineering systems.

Purpose and objectives: This case study presents and applies a novel quasi-experimental design to diagnose the cost-effectiveness of public water treatment systems. The primary objective is to demonstrate a robust methodological framework capable of isolating the causal impact of specific operational interventions on treatment costs and output quality.

Keywords: *Quasi-experimental design, Cost-effectiveness analysis, Water treatment systems, Sub-Saharan Africa, Infrastructure evaluation, Developing nations*

Article Highlights

- Applies a novel quasi-experimental design to diagnose water treatment system cost-effectiveness.
- Finds a 22% reduction in chemical costs for plants receiving advanced filtration upgrades.
- Identifies a consequential 15% increase in energy consumption for backwashing cycles.
- Demonstrates a viable causal framework for infrastructure evaluation beyond descriptive benchmarking.

Methodological Insight

The study employs a difference-in-differences model with plant and year fixed effects to isolate the causal impact of infrastructure upgrades on operational costs.

This study provides a causal diagnostic framework for infrastructure planning in developing nations.