AFRICAN STRUCTURAL ENGINEERING

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

A Multilevel Regression Framework for the Cost-Effectiveness Diagnostics of Process-Control Systems in Rwanda

DOI: 10.5281/zenodo.PENDING_0949 | **Received:** 20 September 2002 | **Accepted:** 04 November 2002 | **Published:** 25 November 2002

Uwimana Niyonsenga[1]

[1] *University of Rwanda*

Correspondence: uniyonsenga@hotmail.com

DOI: 10.5281/zenodo.PENDING_0949

Received: 20 September 2002 | Accepted: 04 November 2002

ABSTRACT

Background: Process-control systems are critical for industrial efficiency and safety in developing economies, yet rigorous methodologies for evaluating their cost-effectiveness in such contexts are lacking. Existing approaches often fail to account for the hierarchical structure of data from multiple industrial sites and varying operational conditions.

Purpose and objectives: This article presents a novel multilevel regression framework designed to diagnose the cost-effectiveness of process-control systems. The objective is to provide a robust statistical methodology that isolates system performance from site-specific contextual factors, enabling more accurate investment decisions.

Keywords: *Multilevel modelling, Cost-effectiveness analysis, Process control systems, Sub-Saharan Africa, Industrial diagnostics, Regression analysis, Developing economies*

Article Highlights

- A three-level hierarchical linear model for nested industrial performance data.
- Derives cost-effectiveness from performance coefficient to amortised cost ratio.
- Identifies crucial diagnostics, like covariance between site spending and benefit.
- Designed for application in data-scarce, developing economy contexts.

Core Model Specification

$y_{ijk} = \beta_{0jk} + \beta_1 x_{1ijk} + e_{ijk}$, where $\beta_{0jk} = \gamma_{00} + u_{0jk} + v_{0k}$. Inference uses profile likelihood confidence intervals.

This article proposes a novel methodological framework, illustrated with simulated data.