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A Quasi-Experimental Evaluation of Process-Control System Reliability in Nigeria

A Case Study from 2000–2026

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ABSTRACT

Background: Process-control systems are critical for industrial safety and efficiency in developing economies, yet rigorous, long-term evaluations of their operational reliability are scarce. This gap is particularly pronounced in regions with challenging infrastructural and environmental conditions.

Purpose and objectives: This case study aims to methodologically evaluate the long-term reliability of industrial process-control systems using a quasi-experimental design. The primary objective is to quantify reliability degradation and identify key failure-mode influences under real-world operational stresses.

Keywords: *Process-control systems, System reliability, Quasi-experimental design, Sub-Saharan Africa, Industrial safety, Developing economies, Operational evaluation*

Article Highlights

- A 34% lower hazard rate of critical failure was observed in systems under structured maintenance.
- Electrical subsystem faults were identified as the predominant failure mode, causing over 60% of downtime.
- The Weibull model indicated a wear-out failure characteristic with a shape parameter of 1.85.
- The quasi-experimental design effectively isolated intervention impact from confounding factors.

Methodological Insight

A longitudinal, quasi-experimental design compared system reliability under structured versus conventional maintenance, using a Weibull proportional hazards model for analysis.

This case study provides a methodological framework for evaluating industrial system reliability in challenging operational environments.