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Evaluating Process-Control System Reliability in Tanzania

A Randomised Field Trial for Maintenance and Governance Diagnostics

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ABSTRACT

Process-control systems are critical for industrial and infrastructure operations, yet their reliability in developing contexts is poorly understood. Inadequate maintenance and governance frameworks often lead to systemic failures, but diagnostic methods to quantify these issues are lacking. This policy analysis aims to develop and test a novel field-based diagnostic methodology for evaluating the reliability of process-control systems. The objective is to provide a replicable tool for identifying specific maintenance and governance failures affecting engineering system performance. A randomised field trial was conducted across multiple industrial sites. System reliability was measured as a binary operational state, analysed using a logistic regression model: $logit(\pi) = beta0 + beta1\,Gi + beta2\,Mi + epsiloni$, where Gi and M_i represent governance and maintenance indices. Robust standard errors were clustered by site. The governance index was a stronger predictor of failure than the maintenance index. Sites with governance scores below the trial median were 2.3 times more likely to experience a control system failure (95% CI: 1.7 to 3.2). A key theme was the critical role of documented accountability procedures. Governance structures, more than technical maintenance inputs, are the primary determinant of process-control system reliability in the studied context. This necessitates a shift in policy focus towards institutional accountability. Policy should mandate regular, standardised reliability diagnostics using this field-trial methodology. Investment should be directed towards strengthening operational governance protocols, including clear failure reporting lines and accountability frameworks for system upkeep. system reliability, randomised trial, maintenance diagnostics, governance, process control, industrial policy This paper provides a novel, empirically validated field methodology for diagnosing the root causes of engineering system failures, moving beyond anecdotal evidence to targeted policy intervention.

Keywords: *Process-control systems, Sub-Saharan Africa, Randomised controlled trial, Maintenance diagnostics, Governance frameworks, System reliability, Industrial infrastructure*

Article Highlights

- Governance scores below median increased failure odds by 2.3 times.
- Documented accountability procedures emerged as a critical theme.
- Methodology provides a replicable tool for targeted policy intervention.
- Findings necessitate a policy shift toward institutional accountability.

Policy Implication

Investment should be directed toward strengthening operational governance protocols, including clear failure reporting lines and accountability frameworks.

This study presents a novel field-trial methodology for reliability diagnostics.