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POLICY ANALYSIS

A Bayesian Hierarchical Model for Manufacturing System Reliability

Policy Implications for Uganda's Industrial Maintenance Governance

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ABSTRACT

Background: System reliability is a critical determinant of industrial productivity and economic growth. In many developing nations, including Uganda, manufacturing sectors are hampered by frequent equipment failures and reactive maintenance cultures, leading to substantial economic losses. Current governance frameworks lack robust, data-driven methodologies to assess and improve system reliability at a national policy level.

Purpose and objectives: This policy analysis article evaluates the application of a Bayesian hierarchical model for quantifying manufacturing system reliability. Its objective is to derive evidence-based policy recommendations for reforming industrial maintenance governance, aiming to shift national practice from reactive to predictive and reliability-centred maintenance.

Keywords: *Bayesian hierarchical modelling, system reliability, industrial maintenance, Sub-Saharan Africa, manufacturing policy, engineering governance, developing economies*

Article Highlights

- Bayesian model estimates show high probability (>0.85) that critical system MTBF falls below international benchmarks.
- Spare parts procurement delays identified as dominant contributor to downtime in over 60% of cases.
- Substantial heterogeneity in reliability parameters across manufacturing plants necessitates tailored policy.
- Framework enables diagnosis of systemic weaknesses across the national industrial base.

Core Policy Recommendation

Establish a national industrial reliability observatory to collect standardised failure data and develop sector-specific maintenance benchmarks.

This analysis provides a statistically rigorous tool for reforming maintenance governance.