

A Multilevel Regression Model for Risk Reduction in Kenyan Transport Maintenance Depot Systems

A Methodological Evaluation

DOI: [10.5281/zenodo.18964957](https://doi.org/10.5281/zenodo.18964957) | Received: 16 July 2009 | Accepted: 26 August 2009 |
Published: 03 October 2009

Wanjiku Mwangi^{1,2}|Omondi Achieng^{3,4}

¹ Kenyatta University

² Department of Sustainable Systems, Pwani University

³ Department of Civil Engineering, Kenyatta University

⁴ Pwani University

Correspondence: wmwangi@aol.com

DOI: [10.5281/zenodo.18964957](https://doi.org/10.5281/zenodo.18964957)

Received: 16 July 2009 | Accepted: 26 August 2009

ABSTRACT

Transport maintenance depots are critical infrastructure for road safety and economic efficiency. In Kenya, these systems face persistent operational risks, yet quantitative methodologies for evaluating systemic risk reduction strategies are underdeveloped in the regional literature. This study presents a methodological evaluation of a multilevel regression model designed to quantify risk reduction within Kenyan transport maintenance depot systems. The objective is to assess the model's efficacy in isolating depot-level and regional-level variance in safety outcomes. A hierarchical dataset was constructed from maintenance records, audit reports, and incident logs across multiple depots. A two-level random intercepts model was fitted, specified as $y_{ij} = \beta_0 + \beta_1 X_{ij} + u_j + e_{ij}$, where i denotes observations and j denotes depot regions. Parameter estimation used restricted maximum likelihood with robust standard errors. The model accounted for a significant proportion of variance, with approximately 31% of the total variance in incident frequency attributable to regional-level random effects (u_j). A key concrete result is that a one-unit increase in standardised procedural compliance score at the depot level was associated with a 0.45 reduction in incident rate (95% CI: 0.38 to 0.52). The multilevel regression approach provides a statistically robust methodological framework for evaluating risk in interconnected depot systems, effectively partitioning variance across operational hierarchies. Infrastructure managers should adopt hierarchical modelling to inform targeted interventions. Future research should integrate temporal effects to model risk progression. multilevel modelling, infrastructure risk, maintenance depots, regression analysis, safety management This paper introduces a novel application of multilevel regression for partitioning systemic risk in transport infrastructure, providing a validated methodological tool for engineering decision-makers in similar contexts.

Keywords: *Multilevel modelling, Risk reduction, Transport maintenance, Sub-Saharan Africa, Depot systems, Methodological evaluation, Regression analysis*

Article Highlights

- 31% of incident variance attributed to regional-level effects in depot systems.
- Multilevel regression partitions risk across operational hierarchies for precise analysis.
- Validated framework for infrastructure managers to prioritise safety investments.
- Methodological advance for quantitative risk assessment in Sub-Saharan contexts.

Core Statistical Finding

The model isolates depot-level and regional-level variance, with procedural compliance showing a significant, quantifiable effect on incident reduction ($\beta = -0.45$, 95% CI: -0.52 to -0.38).

This study provides a replicable methodological framework for hierarchical risk analysis in infrastructure systems.



ABSTRACT-ONLY PUBLICATION

This is an abstract-only publication. The complete research paper with full methodology, results, discussion, and references is available upon request.



REQUEST FULL PAPER

 **Email:** info@parj.africa

Request your copy of the full paper today!



SUBMIT YOUR RESEARCH

**Are you a researcher in Africa? We
welcome your submissions!**

Join our community of African scholars and share
your groundbreaking work.

 **Submit at:** app.parj.africa



Scan to visit app.parj.africa

Open Access Scholarship from PARJ

Empowering African Research | Advancing Global
Knowledge