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A Comparative Evaluation of Maintenance Depot Methodologies for Railway Risk Reduction in Ethiopia

A Quasi-Experimental Analysis

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ABSTRACT

{ "background": "Railway infrastructure in developing nations faces significant operational risks, with maintenance depot methodologies being a critical yet under-researched component of systemic safety. Current practices are often based on imported standards with limited local validation of their efficacy for risk reduction.", "purpose and objectives": "This study aimed to conduct a comparative evaluation of two distinct maintenance depot systems—centralised versus decentralised—to determine their relative effectiveness in mitigating operational risks within a specific national railway network.", "methodology": "A quasi-experimental design was employed, comparing risk metrics across two matched depot groups over an operational period. The primary analysis used a generalised linear model: $\log(\lambda_i) = \beta_0 + \beta_1 \xi + Z_i^T \gamma$, where λ_i is the incident rate for depot i, ξ denotes the depot type, and Z_i is a vector of covariates. Inference was based on robust standard errors clustered at the regional level.", "findings": "The decentralised depot system was associated with a statistically significant reduction in reported safety incidents. The estimated incidence rate ratio was 0.72 (95% CI: 0.61 to 0.85), indicating a 28% lower incident rate compared to the centralised model, after controlling for traffic volume and asset age.", "conclusion": "The decentralised maintenance methodology demonstrated superior performance in reducing operational risks under the studied conditions, suggesting that organisational structure and proximity to operational lines are key factors in depot efficacy.", "recommendations": "Railway authorities should consider a phased transition towards a decentralised depot model, supported by targeted investment in local technical capacity and integrated data systems for continuous risk monitoring.", "key words": "railway maintenance, risk reduction, quasi-experiment, depot methodology, infrastructure safety, comparative study", "contribution statement": "This paper provides the first quasi-experimental evidence comparing centralised and decentralised maintenance depot systems for railway risk mitigation in

Keywords: *Railway maintenance, Risk reduction, Quasi-experimental design, Sub-Saharan Africa, Depot methodologies, Infrastructure safety, Comparative engineering*

Article Highlights

- Quasi-experimental comparison of centralised versus decentralised depot systems.
- Decentralised model showed a statistically significant 28% reduction in safety incidents.
- Analysis controlled for traffic volume and asset age using a generalised linear model.
- Findings challenge imported standards, advocating for

Methodological Note

A quasi-experimental design compared risk metrics across two matched depot groups. Inference was based on robust standard errors clustered at the regional level.

This study provides comparative evidence to inform maintenance strategy in developing railway networks.

locally validated methodologies.	