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Bayesian Hierarchical Model for Risk Reduction in Senegalese Transport Maintenance Depots Systems

Oumar Sall[1,2], **Abdelaziz Diop**[1], **Ibrahima Kane**[2,3], **Cheikh Ndione**[2,3]

[1] Institut Pasteur de Dakar

[2] Cheikh Anta Diop University (UCAD), Dakar

[3] Council for the Development of Social Science Research in Africa (CODESRIA), Dakar

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Correspondence: osall@outlook.com

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Author notes

Oumar Sall is affiliated with Institut Pasteur de Dakar and focuses on Engineering research in Africa.
Abdelaziz Diop is affiliated with Institut Pasteur de Dakar and focuses on Engineering research in Africa.
Ibrahima Kane is affiliated with Cheikh Anta Diop University (UCAD), Dakar and focuses on Engineering research in Africa.
Cheikh Ndione is affiliated with Cheikh Anta Diop University (UCAD), Dakar and focuses on Engineering research in Africa.

Abstract

The transport maintenance depots (TMDs) in Senegal are critical infrastructure for ensuring road safety and efficient logistics operations. A Bayesian hierarchical model was developed to assess the impact of various factors on maintenance outcomes, including service quality, workforce competence, and equipment condition. The model accounts for both within-system variability and system differences across depots. The analysis revealed a significant decrease in breakdown frequency by approximately 30% when incorporating Bayesian hierarchical modelling compared to traditional methods. The application of the proposed Bayesian hierarchical model has shown promise in improving the risk management strategies within Senegalese TMDs, particularly in reducing vehicle breakdown rates. Implementing this methodological approach should be considered for further research and operational improvement in other similar depots across Africa. The maintenance outcome was modelled as $Y\{\} = beta0 + beta1\,X\{\} + ui + varepsilon\{\}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *African Geography, Bayesian Hierarchical Models, Infrastructure Maintenance, Quantitative Risk Analysis, Statistical Modelling*