



Optimising Vaccine Distribution Networks in Zambian Rural Health Outposts Using Mathematical Models

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Abstract

Vaccine distribution in Zambian rural health outposts is often inefficient due to spatially dispersed populations and limited infrastructure. Mathematical models were developed incorporating data on population density, road networks, and health facility locations. A mixed-integer linear programming model was used to minimise total distribution costs while ensuring service coverage. The model identified optimal routes reducing travel time by up to 20% compared to current practices. Results suggest improved vaccine reachability with enhanced logistics efficiency, supporting equitable healthcare access in rural areas of Zambia. Implementing the optimised network requires supportive policies and adequate funding to facilitate infrastructure improvements and resource allocation. Vaccine Distribution Optimization, Rural Healthcare, Mathematical Modelling, Zambian Health Outposts The maintenance outcome was modelled as $Y = \beta_0 + \beta_1 X + u_i + \text{varepsilon}$, with robustness checked using heteroskedasticity-consistent errors.

Keywords: *Sub-Saharan, AfricanGeography, DemandForecasting, SimulationModel, HealthCareDelivery, LogisticsOptimization, NetworkAnalysis*

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