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Optimising Last-Mile Vaccine Delivery: A Cost and Efficiency Analysis of Drone Supply Chains for Malawi's Lake Islands

Tiyamike Phiri[1], **Chikondi Mwale**[2,3]

[1] Department of Internal Medicine, Malawi University of Science and Technology (MUST)

[2] Malawi University of Science and Technology (MUST)

[3] Lilongwe University of Agriculture and Natural Resources (LUANAR)

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Correspondence: tphiri@outlook.com

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Author notes

Tiyamike Phiri is affiliated with Department of Internal Medicine, Malawi University of Science and Technology (MUST) and focuses on Medicine research in Africa.

Chikondi Mwale is affiliated with Malawi University of Science and Technology (MUST) and focuses on Medicine research in Africa.

Abstract

Last-mile vaccine delivery to remote communities remains a significant public health challenge in sub-Saharan Africa. The hard-to-reach islands of Lake Malawi, with dispersed populations and limited transport infrastructure, exemplify the logistical and cost barriers to achieving equitable immunisation coverage. This study aimed to analyse the supply chain costs and operational efficiency of using unmanned aerial vehicles (drones) for last-mile vaccine delivery to these islands, compared to traditional boat-based methods. A comparative cost and efficiency analysis was conducted using operational data from a pilot drone delivery programme. Data on transport times, fuel consumption, personnel requirements, vaccine wastage, and cold chain maintenance were collected and modelled for both drone and boat supply chains across a representative sample of island communities. The drone supply chain demonstrated a 65% reduction in average delivery time and a 23% reduction in per-dose delivery cost compared to the boat-based system. Drone deliveries also maintained consistent cold chain integrity, whereas boat deliveries showed periodic temperature excursions. Drone technology presents a viable and more efficient alternative for last-mile vaccine logistics in geographically challenging island settings like Lake Malawi, offering potential for improved timeliness and cost savings. National immunisation programmes should consider integrating drone delivery for remote island and lakeshore communities. Further research is needed to assess the scalability, community acceptance, and long-term sustainability of such systems within the broader health infrastructure. vaccine delivery, drones, last-mile logistics, supply chain, immunisation, Malawi, islands, cost analysis This paper provides empirical evidence on the costs and operational efficiency of drone-mediated vaccine delivery, contributing practical insights for policymakers and health logistics planners in similar remote African contexts.

Keywords: *Last-mile delivery, vaccine supply chain, unmanned aerial vehicles, cost-effectiveness analysis, sub-Saharan Africa, health systems strengthening, remote populations*

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