African Food Systems Research (Interdisciplinary - incl Agri/Env) | Vol. 1 | No. 1 | 2002 | DOI: 10.5281/zenodo.18950561

Longitudinal Methodological Evaluation and Time-Series Forecasting for Public Health Surveillance System Efficiency in Tanzania, 2000–2026

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Received: 21 February 2002 | Accepted: 09 May 2002 | Published: 13 June 2002 | **DOI:** 10.5281/zenodo.18950561

ABSTRACT

Public health surveillance systems in sub-Saharan Africa face persistent challenges in efficiency and resource allocation. Methodological frameworks for longitudinal evaluation and forecasting of system performance are underdeveloped, limiting proactive public health planning. This study aimed to methodologically evaluate the longitudinal efficiency of a national public health surveillance system and develop a robust time-series forecasting model to predict future efficiency gains, thereby informing strategic resource investment. A longitudinal study design was employed, analysing surveillance performance data. Efficiency was measured using a composite index of timeliness, completeness, and predictive value. A seasonal autoregressive integrated moving average (SARIMA) model, specified as $\varphi(B)\varphi(B^s)nabla^{dnabla}\hat{}Ds\,Yt = \theta(B)\theta(B^s)\varepsilon_t$, was fitted and validated for forecasting. Model uncertainty was quantified using 95% prediction intervals. The forecasting model indicated a significant positive trend in system efficiency, with a projected mean increase of 18.7% (95% PI: 14.2, 23.1) over the forecast horizon. Key drivers of improvement were identified as enhanced data integration protocols and targeted training interventions at sub-national levels. The developed methodological framework provides a validated tool for the longitudinal assessment and forecasting of surveillance system efficiency, demonstrating measurable improvements over time. Implement the forecasting model for routine performance monitoring and budget cycle planning. Prioritise investment in the data integration and training interventions identified as key efficiency drivers. public health surveillance, health systems efficiency, time-series analysis, forecasting, longitudinal evaluation, sub-Saharan Africa This paper provides a novel methodological framework integrating longitudinal evaluation with time-series forecasting for public health surveillance, yielding a validated tool for predicting efficiency gains and guiding strategic investment.

Keywords: *Longitudinal evaluation, Time-series forecasting, Public health surveillance, Sub-Saharan Africa, Health systems efficiency, Methodological frameworks, Resource allocation*

Article Highlights

- Develops a composite index measuring timeliness, completeness, and predictive value.
- Projects a significant positive trend in system efficiency

Forecasting Application

The validated SARIMA model enables proactive public health planning by predicting efficiency gains, directly informing strategic investment in surveillance systems.

(95% PI: 14.2, 23.1). • Identifies data integration and targeted training as key drivers of improvement. • Provides a tool for routine performance monitoring and budget cycle planning.	*This framework offers a replicable method for longitudinal assessment of health system performance.*