



## Methodological Evaluation and Time-Series Forecasting for Efficiency Gains in South Africa's Public Health Surveillance Systems (2000–2026)

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### ABSTRACT

Public health surveillance systems are critical for timely disease response, yet their operational efficiency, particularly in resource-constrained settings, is seldom quantitatively evaluated. In South Africa, while surveillance infrastructure exists, systematic assessments of its performance over time are lacking. This study aimed to methodologically evaluate the efficiency of the national notifiable diseases surveillance system and to develop a forecasting model to quantify potential efficiency gains from targeted interventions. We conducted a longitudinal analysis of surveillance performance metrics. A seasonal autoregressive integrated moving average (SARIMA) model, specified as  $text{\{SARIMA\}(1,1,1)(1,1,1)\}_{12}$ , was fitted to historical timeliness data. The model was used to forecast baseline performance and simulate the impact of reducing data processing delays. The forecasting model indicated that a 15% reduction in median reporting lag could yield a 22% improvement (95% prediction interval: 18 to 26) in overall system timeliness by the forecast horizon. The greatest efficiency gains were projected for syndromic surveillance streams. The applied time-series modelling provides a novel, quantitative framework for evaluating surveillance efficiency and demonstrates that modest reductions in procedural delays can generate substantial systemic improvements. Surveillance programmes

should adopt similar forecasting techniques for strategic planning. Resources should be prioritised towards streamlining data flow in identified bottleneck areas to achieve measurable efficiency gains. public health surveillance, health systems, efficiency, forecasting, time-series analysis, operational research This paper introduces a novel application of SARIMA modelling for the ex-ante evaluation of public health surveillance efficiency, providing a replicable tool for evidence-based system strengthening.

**Keywords:** *Public health surveillance, Health systems efficiency, Time-series analysis, Sub-Saharan Africa, Operational research, Health informatics, Forecasting models*

#### Article Highlights

- Applies SARIMA modelling to forecast efficiency gains in public health surveillance.
- Projects that targeted reductions in procedural delays yield substantial systemic improvements.
- Provides a quantitative framework for evidence-based surveillance system strengthening.
- Identifies syndromic surveillance streams as having the greatest potential for gains.

#### Forecast Impact

The SARIMA(1,1,1)(1,1,1)<sub>12</sub> model forecasts that streamlining data flow in bottleneck areas can improve system timeliness by 18–26%.

*This study offers a replicable methodological framework for surveillance programme evaluation.*

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