Time-Series Forecasting Model Evaluation for Cost-Effectiveness of Municipal Water Systems in Rwanda

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Abstract

Municipal water systems in Rwanda have been pivotal for ensuring access to clean drinking water and sanitation services. However, their cost-effectiveness over time remains a subject of interest. A variety of time-series forecasting models were applied to historical data on municipal water systems investment costs and service delivery metrics. Models considered included ARIMA (Autoregressive Integrated Moving Average) and SARIMAX (Seasonal Autoregressive Integrated Moving Average with eXogenous regressors). The analysis revealed significant seasonal patterns that influenced the forecasting accuracy, particularly in relation to rainfall impacts on water supply reliability. ARIMA models outperformed others in capturing these seasonal effects and provided more accurate cost-effectiveness predictions over a three-year horizon. Further research should explore integrating exogenous variables such as economic indicators or climate data into the forecasting models to enhance their predictive power. Model estimation used $\hat{\{\theta\}} = argmin\{\theta\} \, sumiell(yi, f\theta(\xi)) + \lambda lVert\theta rVert 2^2$, with performance evaluated using out-of-sample error.

Keywords: *Geographic, Time-series, Econometrics, Forecasting, Sustainability, Evaluation, Performance*

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