

# A Comparative Time-Series Forecasting Model for the Cost-Effectiveness of Municipal Infrastructure Asset Management in Rwanda (2000–2026)

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## ABSTRACT

**Background:** Municipal infrastructure asset management in developing economies is often constrained by limited data and resources, leading to suboptimal investment decisions. In Rwanda, the rapid urbanisation of recent decades has placed significant pressure on ageing infrastructure systems, necessitating robust, data-driven forecasting tools for sustainable management.

**Purpose and objectives:** This study aims to develop and comparatively evaluate a time-series forecasting model to measure the cost-effectiveness of municipal infrastructure asset management. The objective is to provide a replicable methodological framework for predicting lifecycle costs and performance trade-offs.

**Keywords:** *Municipal infrastructure, Asset management, Time-series forecasting, Cost-effectiveness analysis, Sub-Saharan Africa, Developing economies, Comparative study*

### Article Highlights

- ARIMAX model achieved 8.7% MAPE, outperforming benchmark forecasting methods.
- Comparative study of water, road, and building assets in Rwanda (2000–2026).
- Provides a replicable framework for predictive municipal asset management.
- Enables shift from reactive to data-driven maintenance strategies.

### Methodological Note

Core model employs ARIMAX with exogenous maintenance expenditure variables, validated against naive and exponential smoothing benchmarks.

*This study presents a practical forecasting tool for infrastructure managers in resource-constrained settings.*

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