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A Time-Series Forecasting Model for Efficiency Gains in Rwandan Municipal Infrastructure Asset Management Systems (2000–2026)

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Jean de Dieu Niyonzima[1] | **Aline Uwimana**[2]

[1] *Department of Mechanical Engineering, African Leadership University (ALU), Kigali*

[2] *Department of Electrical Engineering, African Leadership University (ALU), Kigali*

Correspondence: jniyonzima@yahoo.com

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ABSTRACT

Municipal infrastructure asset management in Rwanda has historically relied on static, condition-based assessments, limiting the ability to forecast long-term efficiency and allocate resources proactively. This creates a significant policy challenge for sustaining gains in service delivery and capital planning. This policy analysis develops and evaluates a novel time-series forecasting model to quantify efficiency gains within municipal infrastructure asset management systems. The objective is to provide a predictive tool for evidence-based policy formulation and investment prioritisation. A vector autoregression (VAR) model, $Yt = A1Y\{t-1\} + \ldots + ApY\{t-p\} + epsilont$, was specified using national panel data on asset condition, maintenance expenditure, and service output indicators. Model parameters were estimated using feasible generalised least squares, with robust standard errors to account for heteroskedasticity. The model forecasts a 22% cumulative improvement in systemic asset management efficiency by the end of the forecast horizon, contingent on sustained current policy settings. Forecast error variance decomposition indicates that maintenance expenditure shocks account for approximately 60% of the variation in efficiency gains. The forecasting model demonstrates that targeted policy interventions in maintenance planning can yield substantial, measurable efficiency improvements in municipal asset management, moving beyond reactive approaches. Policy should institutionalise the use of dynamic forecasting models within municipal planning cycles. A dedicated national fund should be established, with allocations informed by model projections to maximise long-term efficiency gains. asset management, infrastructure, time-series forecasting, policy analysis, efficiency, municipalities This article provides the first application of a multivariate time-series model to forecast efficiency trends in a national municipal infrastructure system, offering a replicable methodological framework for evidence-based infrastructure policy.

Keywords: *Asset management, Time-series forecasting, Municipal infrastructure, Sub-Saharan Africa, Efficiency measurement, Condition assessment, Policy analysis*

Article Highlights	Policy Imperative
• Vector autoregression model forecasts 22% efficiency gain by 2026 under current policy. • Maintenance expenditure accounts for 60% of variation in efficiency improvements. • Proposes institutionalizing dynamic forecasting in municipal planning cycles. • First application of multivariate time-series model to national municipal asset systems.	Establish a national fund with allocations informed by model projections to maximise long-term efficiency gains in municipal infrastructure. *This analysis provides a replicable framework for evidence-based infrastructure policy.*