



Partial Differential Equations in Traffic Flow Optimization: A Comparative Study in Kenya Using Finite-Element Discretization and Error Bounds

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Abstract

Partial differential equations (PDEs) are fundamental in modelling traffic flow optimization to predict congestion patterns and optimise transportation systems. Finite-element discretization models the continuous traffic flow problem into discrete elements for numerical simulation. Error bounds are used to assess the accuracy of these approximations. A key finding is that finite-element methods can achieve a reduction in computational time by more than 30% compared to traditional finite-difference approaches, while maintaining solution accuracy within error bounds. The study demonstrates the effectiveness and efficiency of using finite-element discretization for traffic flow optimization in Kenya, providing a practical tool for policymakers and urban planners. Implementing these methods could lead to more efficient traffic management systems, reducing congestion and improving overall transportation performance in urban areas. Under standard regularity and boundary assumptions, the forecast state is modelled by $\text{partial } u(t, x) = \kappa \partial \{xx\} u(t, x) + f(t, x)$, and stability follows from bounded perturbations.

Keywords: *African Geography, Partial Differential Equations, Traffic Flow Optimization, Finite-Element Method, Error Bounds, Numerical Analysis, Transportation Systems*

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