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Asymptotic Analysis and Identifiability Checks of PDE Models for Traffic Flow Optimization in Nigeria

Felix Odufa[1]

[1] Nnamdi Azikiwe University, Awka

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Correspondence: fodufa@hotmail.com

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Author notes

Felix Odufa is affiliated with Nnamdi Azikiwe University, Awka and focuses on Mathematics research in Africa.

Abstract

This study addresses the modelling of traffic flow optimization in Nigeria by employing Partial Differential Equations (PDEs), focusing on analytical methods for understanding and predicting traffic behaviour. The methodology involves deriving a system of hyperbolic PDEs that describe traffic dynamics using conservation laws. Asymptotic analysis is applied to simplify these equations in specific limits, such as low vehicle density or high-speed scenarios. Identifiability checks are conducted by analysing the sensitivity of model outputs to changes in parameters. The asymptotic solutions reveal a clear distinction between steady-state and transient behaviour under different traffic densities, with significant differences observed around critical density thresholds. The identifiability analysis confirms that key parameters related to vehicle speed and capacity can be reliably estimated from field data, provided certain conditions are met regarding the temporal dynamics of traffic flow. Further research should focus on validating these models in real-world scenarios using collected traffic data and incorporating more complex factors such as road geometry and weather effects. Under standard regularity and boundary assumptions, the forecast state is modelled by $partialt\,u(t,x)=\kappa ¿\partial\{xx\}u(t,x)+f(t,x)$, and stability follows from bounded perturbations.

Keywords: *Nigerian, Asymptotic, Identifiability, Stability, Numerical, Simulation, Boundary*

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