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REVIEWER'S REPORT

Manuscript No.: IJAR-50436 Date: 27-02-2025

Title: Wastewater Pipe Rating Classification Using Physics-Based K-Nearest Neighbors: A Data-Driven Approach for Reliable Infrastructure Assessment

Recommendation:
Accept as it is……**YES……**
Accept after minor revision……
Accept after major revision ……
Do not accept (*Reasons below*) ……

Rating	Excel.	Good	Fair	Poor
Originality	√			
Techn. Quality		√		
Clarity		√		
Significance			√	

Reviewer's Name: Mir Tanveer

Reviewer's Decision about Paper: **Recommended for Publication.**

Comments (*Use additional pages, if required*)
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Reviewer's Comment / Report

Title Analysis: The title accurately represents the study's focus on wastewater pipe rating classification using a physics-based K-Nearest Neighbors (K-NN) approach. It conveys the methodological innovation and the study's application to infrastructure assessment.

Abstract Evaluation: The abstract effectively summarizes the study's objectives, methodology, and key findings. It highlights the limitations of traditional pipe rating systems and the advantages of integrating physics-based features into a data-driven K-NN classification framework. The reported 92.5% classification accuracy provides a compelling justification for the proposed approach. The abstract is concise, well-structured, and informative.

Introduction Assessment: The introduction clearly presents the significance of wastewater infrastructure assessment and the challenges posed by aging pipeline networks. The discussion on the limitations of conventional pipe rating systems and the necessity of incorporating physical principles into machine learning models is well-articulated. The research objectives are explicitly outlined, providing a logical progression toward the proposed physics-based K-NN approach.

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Literature Review Analysis: The literature review provides a comprehensive examination of existing methodologies for wastewater pipe rating. It effectively contextualizes the study by discussing empirical, statistical, and data-driven approaches. The inclusion of physics-guided machine learning applications in other domains strengthens the argument for its application to wastewater infrastructure. The discussion on K-NN's relevance and its weighted adaptation in fault detection and medical diagnosis further establishes the study's foundation.

Methodology Evaluation: The methodology section is well-structured, detailing the data sources, feature engineering process, and classification approach. The integration of municipal utility records, field inspections, and laboratory analyses ensures a robust dataset. The discussion on data cleaning and integration processes, including handling missing values and outliers, enhances the credibility of the study's findings. The dataset of 2,500 wastewater pipe segments is adequately sized for machine learning applications.

Technical Merit: The study's emphasis on incorporating domain-specific physics-based features, such as hoop stress, corrosion rate, and material stiffness, distinguishes it from standard machine learning approaches. The weighted K-NN distance metric, assigning greater importance to critical physical attributes, enhances classification accuracy and interpretability. The empirical validation against benchmark models, including standard K-NN, logistic regression, and random forests, demonstrates methodological rigor.

Conclusion & Impact: The study contributes valuable insights into wastewater infrastructure management by presenting a reliable, interpretable, and scalable classification framework. The findings offer practical implications for municipal agencies, enabling proactive maintenance strategies that minimize pipe failures and associated costs. The research also aligns with broader trends in physics-guided machine learning, reinforcing its interdisciplinary significance.

Overall Assessment: The study is well-conceived, methodologically sound, and effectively communicated. The integration of physics-based features into a K-NN framework provides a compelling advancement in wastewater pipe classification. The discussion is comprehensive, and the empirical validation strengthens the study's impact on infrastructure asset management. The report is well-structured, with clear articulation of objectives, methodology, and findings.