

Evaluation of the Potential Implication of Simulation Modeling in Enhancing Maintenance Monitoring and Decision Making of Road Infrastructure

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Abstract

An essential measure of a nation's development is its road network. Thus, maintaining road infrastructure promotes economic growth by improving connectivity and accessibility, reducing vehicle operating costs, and ensuring safer travel. In South Africa, many communities struggle to access public services due to the deteriorated state of roads. Provincial and municipal road networks are currently facing a maintenance crisis, evidenced by an R197 billion backlog, despite the national highway system remaining of relatively high quality. Additionally, artificial intelligence and related disruptive technologies have transformed the scientific domain; yet, civil engineering and infrastructure management, specifically, are trailing behind the technology adoption trajectory. Currently, there is scant information regarding the utilization of technology in road maintenance. To derive profound insights from current research and offer guidance for subsequent investigations, this study aims to assess the potential implications of simulation modeling for enhancing road network maintenance. Among the many simulation methods, system dynamics (SD) has been selected for this study due to its ability to provide insights into the challenges of dynamic complexity, a capability demonstrated through the application of the system dynamics methodology. The study successfully achieved its objective by conducting a systematic literature review and a content analysis regarding the utilization of simulation modeling in road maintenance. The findings revealed that effective road maintenance management can be realized through the integration of artificial intelligence and the application of system dynamics, as simulation enables authorities to test different maintenance systems in a virtual environment to identify the most efficient approach before implementation.

Keywords

Artificial intelligence, Simulation modeling, System dynamics, and Road maintenance.

Biography

Sinah Marungane is a Master of Engineering in Engineering Management student at Tshwane University of Technology (TUT) in the Faculty of Engineering and the Built Environment. She has two Bachelor of Technology degrees, one in Civil Engineering and one in Project management, from Tshwane university of Technology (TUT), a National Diploma in Civil Engineering from Durban University of Technology (DUT), and a National Certificate in Municipal Financial Management from the Local Government Sector Education and Training Authority (LGSETA). Prior to joining the family business, which specializes in consulting and construction, she worked for three Municipalities in Limpopo: Mopani District Municipality in the project management unit, Greater Giyani Municipality in the roads and stormwater section, and Ba-Phalaborwa Municipality in the project management and water and sanitation section. Sinah is a registered member of the South African Institution of Civil Engineering (SAICE) and a Candidate Technologist for Engineering Council of South Africa (ECSA).