Spatiotemporal Modeling for Automating Construction Work Zone Impact Assessments

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Highway infrastructure improvement projects to achieve the nation's aging highway system have placed significant stressors on the urban traffic environment, causing costly traffic delays and disruptions to the traveling public and surrounding communities. For example, 2012 Annual Urban Mobility Report issued by Texas A&M Transportation Institute (TTI) found that severe traffic congestion in heavily trafficked metropolitan areas stole an extra 38 hours and 19 gallons of fuel from the average one auto commuter, all at a cost of $818 only in 2011.To address this issue, changes to the Work Zone Safety and Mobility Rule, enacted by the Federal Highway Administration in October 2007, mandate that Construction Work Zone (CWZ) impact assessments be completed for all federally-funded highway infrastructure improvement projects. A major focal point of the rule mandates that state transportation agencies (STAs) develop and implement Transportation Management Plans (TMPs) for all projects. Developing a TMP has typically been considered a daunting task for STAs to manage, often impeding timely delivery of a project while adding cost. The primary problem is lack of standardized methods and analytical tools for developing TMPs. Although the existing research provides valuable proof-of-concept studies, a rigorous theoretical and practical framework that blends traffic prediction techniques and CWZ impact assessments is crucial for selecting the most effective TMP alternatives. To circumvent this challenge while contributing to the global body of knowledge, this study aims to promote synergetic pollination between transportation construction management and traffic prediction techniques. The ultimate objective of this study is to create a decision-support model framework called Spatiotemporal construction Work zone Assessment for Transportation management plans (SWAT), test, and validate the SWAT. The proposed framework aims to automate CWZ impact assessments and test whether it can accurately and reliably predict the potential impacts of a CWZ on road users, affected communities, and business enterprises. The discussed objectives will be accomplished by conducting a five-stage methodology that involves: 1) spatiotemporal data summarization through thousands of traffic flow detection sensors installed and operated on 18 freeways in Los Angeles County in California; 2) data characterization in a set of distinct clusters to capture spatiotemporal characteristics; 3) the future traffic pattern prediction in and between CWZs by taking a multilevel cluster-driven approach to generalize the framework; 4) quantification of work zone impacts by incorporating potential traffic delays along with road user costs into "what-if" lane closure scenarios with respect to construction alternatives; and 5) empirical and experimental validation of the SWAT. The end result will quantify several critical components for a sounder TMP, such as potential round-the-clock traffic patterns applicable to similar given road network during lane closures, queue delays, and road user costs. The successful research result and findings will bring a breakthrough in automatic impact assessments of CWZ, which enables engineers and decision-makers, particularly STAs, to facilitate progress on project commencement with better-informed transportation construction management strategies and to reduce major congestions by knowing its potential impact ahead of lane closures. This study will greatly benefit STAs, the general traveling public, and society in general by significantly improving mobility in and between CWZs and positively impacting regional development.

Key Words: Highway Infrastructure Improvement, Construction Work Zone Impact Assessments, Transportation Construction Management, Transportation Management Plan, Spatiotemporal Modeling