The College of Graduate Studies and the College of Engineering Cordially Invite You to

PhD Dissertation Defense

Entitled

PREDICTIVE MODELLING OF ROAD DETERIORATION USING AN ARTIFICIALLY INTELLIGENT BAYESIAN BELIEF NETWORKS APPROACH

by

Babitha Elizabeth Philip

Faculty Advisor

Dr. Hamad Al Jassmi, Department of Civil and Environmental Engineering

College of Engineering

Date & Venue

Tuesday, 7 November 2023

7:00 pm

Room (1117), F1 Building

Abstract

The ability to predict road deterioration is the cornerstone for developing a reliable Pavement Management System (PMS) that optimizes pavement maintenance programs. Such prediction capacity becomes increasingly important, especially when highway agency funds are confined. This research focuses on the development of prediction models based on an artificial intelligence technique, Bayesian Belief Networks (BBN), that aid decision-makers in forecasting expected road distress curves on the lights of various (e.g., environmental, traffic, and road-specific) factors and maintenance decisions. The novelty of this research revolves around deploying BBNs which allow analysts to yield Markovian predictions of annual road deterioration based on incomplete and/or uncertain historical data, which is probabilistically inferred based on the interrelations of factors modelled in the Bayesian Networks. Such probabilistic inferences not only tackle a gap in current road deterioration modelling literature, but are also deemed to provide a reasonable alternative over costly data collection campaigns and assist in road condition diagnoses and assessment efforts in cases where data are only partially available. The major objectives of the study are to: (1) Estimate the correlations between various deterioration factors to optimize the data collection efforts using machine learning algorithms (Correlation analysis model), (2) Develop a prediction model to estimate the probabilistic values of deterioration factors using Dynamic BBN analysis based on Markov chain process, to aid in the development of temporal graphs representing the pattern of deterioration factors in the future years (Time-series prediction model), (3) Develop a decision-support system which generates suitable alerts whenever the deterioration factors cross the safe limits, enabling the practitioners to conduct appropriate repair and maintenance activities at the right time to increase the service life of the pavements (Decision-support system). The BBN models were trained using a collection of 3,272 road sections, representing a variety of 32 arterial, collector, freeway, and expressway roads in UAE from 2013 to 2019. The BBN models developed in this study show high accuracy with a contingency table fit of over 85% for the correlation analysis models and over 80% of overall precision and reliability rate for the performance prediction models. The proposed BBN approach provides flexibility to illustrate road conditions under various scenarios, which is beneficial for pavement maintainers to establish a decision support system that is aimed not only at prioritizing maintenance during the operation stage, but also to design pavements during the design stage, with an upfront foresight into the life-cycle implications of their design, ultimately improving and/or extending their deterioration curves.

Keywords: Road distress parameters, Uncertainty, Bayesian belief network, Decision-making, Pavement Management System.