ABSTRACT

Name of student: **Mohit Batola** Roll no: **20103068**

Degree for which submitted: **Master of Technology**

Department: **Civil Engineering**

Thesis title: **Investigating the impact of pavement roughness on road safety using causal inference techniques**

Name of Thesis Supervisor: **Dr. Aditya Medury**

Month and year of thesis submission: **January, 2023**

The traffic safety concerns of highways are governed by many factors, such as traffic conditions, pavement design, geometric designs and pavement conditions. The evolution of pavement condition itself is also routinely modeled as a function of various traffic, design and environmental factors. However, the impact of pavement condition on road safety is relatively less scrutinized in the road safety literature. Pavement conditions have been considered in road safety modeling by incorporating different pavement-related distresses and composite indexes as explanatory variables, such as rut depth, international roughness index (IRI), pavement serviceability index (PSI), pavement condition index (PCI), etc. In particular, the international roughness index (IRI) is a widely used, composite measure of pavement condition that is extensively adopted for pavement maintenance decision-making. However, a shortcoming of these approaches is that due to systematic differences in how road segments are maintained, there may be biases in terms of which roads exist in (relatively) better or worse condition states. Consequently, the utilization of standard regression models may not necessarily yield a causal interpretation of pavement roughness coefficients.

To investigate the causal relationship between pavement roughness and road safety, this work explores the propensity score potential outcome (PSPO) framework to assess how pavement roughness affects traffic safety. Five-year data (2011-2015) from Ohio (United States) were taken from the Highway Safety Information System (HSIS) for the purposes of this study. The road segments were classified into five treatment levels (poor, average, fair, good and excellent) on the basis of their international roughness index. Pairwise comparisons were conducted by considering a lower roughness class as a treated group while consider higher roughness levels (e.g., poor) as the control group. Binary logit regression models are used for the estimation of the propensity score (PS) using one-to-one nearest neighbour matching (NNM) with a suitable caliper width to get good balance in covariates across matched treatment and control groups. Count regression models were used to estimate treatment effects which are also represented in the road safety literature as crash modification factors (CMFs).

The results indicate a positive treatment effect of improved pavement condition on different crash types (total crashes, crashing involving lane changing, two-wheelers, among others). This effect was found to reduce as the intensity of treatment decreases. The utilization of the PSPO approach yielded some differences in the statistical significance of the point estimates within the models estimated on the original and the matched data. However, the interval estimates of treatment effects with and without the propensity score-based matching demonstrated substantive overlap. The sensitivity of the results to different modeling assumptions was also assessed, which raised certain concerns on discretizing a continuous treatment variable. Some other shortcomings of the adopted methodology as well as multiple avenues for future research extensions were also identified.