

Integrated Analysis of Skid Resistance, Texture, and Geometric Factors for Enhanced Road Safety on the Southern Expressway

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Abstract

Road safety remains a critical concern worldwide, especially on high-speed roads such as expressways, where traffic flow is dense and road geometries are complex. The Southern Expressway in Sri Lanka, the country's first expressway, has contributed significantly to reducing travel time and promoting economic development. However, it has also been associated with a considerable number of road accidents, which raise serious concerns regarding road safety. This research aims to explore the factors contributing to the severity of accidents on the Southern Expressway, focusing on the impacts of road geometry, surface conditions, environmental factors, and lighting. This study investigates a decade of data from 2012 to 2022, collected from the Expressway Operations Maintenance and Management Division (EOM & M). The data encompasses various accident characteristics, including accident time, location, weather conditions, and lighting conditions, as well as road geometry parameters such as horizontal curvature, vertical alignment (K-value), and surface texture. The research applies a combination of statistical techniques and machine learning models to identify key factors influencing accident severity and predict accident outcomes. The study found that road geometry, especially curves, gradients, and poor lighting conditions, significantly influences the severity of accidents. Wet weather conditions were also identified as a key factor, as they reduced the effectiveness of skid resistance, leading to increased accident risk. The analysis highlighted the role of road surface conditions such as skid resistance, which is essential in preventing accidents under adverse weather conditions. Principal Component Analysis (PCA) and K means clustering were employed to reduce the dataset's dimensionality and identify the most significant contributing factors. Additionally, machine learning models, including Random Forest, Logistic Regression, and Support Vector Machines (SVM), were used to predict accident severity. The Random Forest model achieved an accuracy rate of 91.5%, demonstrating its potential to accurately predict accident severity and identify high-risk zones. The study emphasises the importance of improving road design, particularly in high-risk areas. Enhancing road surface conditions, such as improving skid resistance, and upgrading lighting in poorly lit zones, could significantly reduce accident severity. Furthermore, integrating real-time traffic and weather data into predictive models would enable timely interventions and better safety management. The research also advocates for the use of advanced technologies such as GIS-based hotspot analysis and digital road signs to increase driver awareness and promote safer driving behaviors. In conclusion, this research underscores the need for a comprehensive approach to road safety management on expressways, combining better road design, predictive modelling, and real-time data integration. By implementing these recommendations, the Southern Expressway's safety performance can be significantly improved, ultimately reducing accident severity and contributing to safer transportation. The findings provide valuable insights for road safety

management, particularly for expressways in emerging economies like Sri Lanka, and can serve as a model for other regions facing similar challenges.

Keywords: *accident severity, hotspot analysis, machine learning, K-mean clustering*

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