

**DEVELOPMENT OF A METHODOLOGY TO
EVALUATE SAFETY PERFORMANCE IN LOW
VOLUME ROADS**

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Degree of Master of Philosophy

Department of Civil Engineering

Faculty of Engineering

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DECLARATION OF THE CANDIDATURE & SUPERVISOR

I declare that this is my own work and this thesis does not incorporate without acknowledgment any material previously published submitted for a Degree or Diploma in any other university or institute of higher learning and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Signature of the supervisor:

Date: 27.01.2022

Dr. H.R. Pasindu

DEDICATION

I dedicate this dissertation to Dr. H. R. Pasindu and Dr. T.W.K.I.M. Dias, my supervisors, and mentors who encouraged and guided me to complete this study successfully.

Also, I dedicate this dissertation to my parents and sister who supported me and stayed with me throughout all the good and hard times.

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14.01.2022

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ABSTRACT

Road safety is a vital element of the road's overall function, which is often neglected in decision-making for road maintenance management. As a result, the safety issues, especially in rural roads, remain without funding to implement the necessary countermeasures. One constraint faced by local authorities is the lack of analysis tools to select appropriate safety treatments within the available budget.

Low-volume roads provide connectivity between residential/commercial areas and the national road network. They are especially critical in rural areas to provide accessibility to the community for social and economic needs. Low volume roads account for nearly 61% of the road network length in Sri Lanka. With the rapid motorization taking place in Sri Lanka, it is expected that traffic on these roads will increase significantly in the future. However, some of these roads have not been developed according to the standard design guidelines and raise major safety issues on such roads as a result. Considering the expected growth in traffic and prevailing issues concerning roadway design, the safety level decrease in these roads raises risk to the road user. Therefore, it is essential to evaluate the safety performance of low volume roads. Existing safety evaluation methodologies rely on traffic data, and accident statistics, which may not be readily available for the low volume road network. Therefore, it is necessary to develop a non-subjective methodology to evaluate the safety performance of low-volume roads, considering the data limitations present in developing countries. This study analyses the main casual factors of low volume road accidents and a novel approach, i.e., Cumulative Safety Index: CSI, designed to evaluate the safety performance of low volume roads considering the data limitations present in developing countries.

This study also proposes a methodology to incorporate road safety performance in rural roads in maintenance planning using a multi-objective optimization approach. Road safety performance is defined in terms of the CSI, which is computed based on the severity, exposure, frequency of safety issues that road safety audits have identified. The safety performance and pavement condition-related indices, such as International Roughness Index: IRI, pothole number, etc., are included in the Multi-Objective Optimization: MOO decision criteria analysis. It comprises two objectives: minimize network IRI, and minimize network CSI. Applicability of the developed model has been demonstrated from the illustrative example of a rural road network. Results have shown that roads with safety

issues can also be prioritized in budget allocation while ensuring the network-level pavement condition can be maintained at a reasonable level. This methodology offers a simplified approach to incorporate road safety issues in rural road maintenance planning.

This study presents a methodology to logically determine the safety treatment criteria for a selected road to increase the safety performance at the project level. The safety treatments are taken based on a linear programming model that optimizes the safety performance of the selected road. CSI represents the safety performance of the road, which is determined based on the prevailing issues on that road. The model comprises the objective function that maximizes the safety performance of the selected road concerning the number of prevailing safety issue types. This model is used to identify the optimal safety treatment scheme for the road chosen, ensuring prevailing road safety issues are effectively addressed. The objective function consists of the Initial CSI of the selected road and the safety improvement after treating relevant issue type coupled with a binary decision variable.

Keywords: Low-volume roads, Safety, Safety Performance Evaluation, Optimization Techniques, Pavement Management System, Network and Project Level Analysis

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LIST OF ABBREVIATIONS

Abbreviation	Description
RDA	Road Development Authority
PRDA	Provincial Road Development Authority
AADT	Annual Average Daily Traffic
CAREC	Central Asia Regional Economic Cooperation Program
ADB	Asian Development Bank
EPDO	Equivalent Property Damage Only
CSI	Cumulative Safety Index
MOO	Multi Objective Optimization
HSM	Highway Safety Manual