# Developing Road Roughness Deterioration Models for Pavement Management System in Developing Countries, Case Study: Lao People's Democratic Republic

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Pavement Management System (PMS) plays a crucial role in forecasting pavement performance in the future, estimating maintenance and rehabilitation needs, and setting priorities among projects under restricted funds. Pavement performance prediction models are an essential component in any PMS. Successful implementation of a PMS requires accurate models for optimizing maintenance and rehabilitation strategies throughout the pavement service time. Laos' road maintenance strategy is mainly based on assessing pavement roughness in terms of the International Roughness Index (IRI).

Laos PMS utilizes default Highway Development and Management (HDM-4) pavement deterioration models without calibration to predict the IRI, which leads to an enormous error between measured and predicted IRI values. The calibration of the HDM-4 models demands detailed and precise distress data. Such data records are not fully available for Laos yet, making it difficult to calibrate the HDM-4 IRI prediction model for local conditions. So, the domestic roughness deterioration models for various pavement categories have to be developed to cover the influence of Laos's local conditions, which would have direct implementation without any calibration factors.

In this study, Multiple Linear Regression (MLR) models, Artificial Neural Network (ANN) models, and Adaptive Neuro-Fuzzy Inference System (ANFIS) models were developed to forecast the IRI of Laos National Road Network (NRN). The data available in Laos PMS were utilized to create indigenous IRI prediction models for Double Bituminous Surface Treatment (DBST) and Asphalt Concrete (AC) pavement sections. The final database consisted of 83 sections with 269 observations over a 1850 km length of DBST NRN and 29 sections with 122 observations over a 718 km length of AC NRN. The proposed models predict IRI as a function of pavement age and Cumulative Equivalent Single-Axle Load (CESAL).

The goodness of fit of the proposed models was compared. The results show that ANN models yielded higher prediction accuracy than MLR and ANFIS models. The statistical evaluation results of the training dataset reveal that both ANN models (DBST and AC) have good prediction ability with high values of coefficient of determination ($R^2$ = 0.96 and 0.94) and low values of Mean Absolute Error (MAE = 0.23 and 0.19) and Mean Squared Percentage Error (RMSPE = 7.03 and 9.98). Despite the better prediction of ANN models' to

IRI values, MLR modes might be chosen to be incorporated in Laos PMS because of their simplicity and ease of implementation.

The developed IRI models will assist authorities accurately in predicting pavement condition in the future; as a result, estimating maintenance and rehabilitation needs, and setting priorities among projects under restricted funds. The proposed methodology in this study can be used to develop IRI models for the other roads categories (PRs, DRs, URs, RRs, and SRs) in Laos. Eventually IRI prediction models could be used in other developing countries with the same pavement type characteristics, road categories, vehicle classification, and traffic loads.