



# Prioritization of pavement maintenance sections using objective based Analytic Hierarchy Process

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## Abstract

The application of Analytic Hierarchy Process (AHP) method for the prioritization of pavement maintenance sections is widespread now-a-days. Although the evaluation of pavement maintenance section through AHP method is simple, where the relative importance (on Saaty's scale) assigned to each parameter in the hierarchy varies between the experts (transportation professionals) consulted, which leads to discrepancies in the final rankings of the sections', due to the subjectivity in the process. Further, experts base their decisions solely on their experience while consideration is not given to the actual quantitative physical condition of the roads. To overcome these difficulties an objective based AHP method is proposed in this study, where pairwise comparison values are assigned based on the collected field data from a road network in Mumbai city, consisting of 28 road sections. The final ranking list of candidate sections takes into consideration the priority weight of alternatives, which reflect the road conditions. The solution of priority ratings of AHP method is compared with the corresponding solution of road condition index method, a traditional pavement maintenance procedure. The findings of the present study suggest that objective based AHP method is more suitable for the prioritization of pavement maintenance of roads. © 2017 Chinese Society of Pavement Engineering. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Keywords:** Prioritization; Analytic Hierarchy Process; Road condition index; Objective method; Rating and ranking

## 1. Introduction

Excessive road deterioration, due in part to improper and irregular maintenance, results in increased Vehicle Operating Costs (VOC), increased number of accidents and in general reduced reliability of transport services. The function of pavement maintenance is to diminish pavement deterioration and extend the life of a pavement. Pavement maintenance, if not done at appropriate times in a preplanned manner, negatively impacts the transport

system [1]. Prioritization is executed in a sequential manner, beginning with enlisting of the pavement maintenance projects required to be implemented. Based on their relative perceived urgency of need for repair, engineers and managers are able to prioritize and schedule the maintenance of pavement sections. To prioritize pavement maintenance activities, a number of decision making methods have been introduced and implemented under Pavement Management System (PMS) study. These methods vary from simple ranking to complex optimization [2]. The main objective of the PMS is to avoid the bias derived from judgment and help in the decision-making by using objective information based on pavement distress and other objective measures. Most of the highway agencies have adopted a practice of expressing the pavement maintenance priority in the form of priority index, which is computed by means of empirical expression. Although using a mathematical

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equation is convenient, often they do not have a clear physical meaning and cannot accurately combine different factors into a single equation. This inevitably leads to overlooking of various contributing effects of actual characteristics of distress [3]. Furthermore, not all the factors and parameters involved can be expressed quantitatively and measured in compatible units. In view of these shortcomings and constraints, Analytic Hierarchy Process (AHP) is the most suitable choice for the prioritization of pavement sections for maintenance at network level. Although the evaluation of the pavement maintenance section through AHP method is simple, but the relative importance (on Saaty's scale) assigned to each parameter in the hierarchy varies between the experts (transportation professionals) consulted, which leads to discrepancies in the final rankings of the sections. Hence the process can be termed subjective. Further, experts base their decisions solely on their experience while due consideration is not given to the actual quantitative physical condition of the roads. To overcome these difficulties an objective based AHP method is proposed in this study, where pairwise comparison values are assigned based on the collected field data from a road network in Mumbai city, consisting of 28 road sections. Furthermore, the evaluated results of priority ratings of objective based AHP method are compared with the results of subjective based Road Condition Index (RCI) method for the validation purpose.

## 2. Review of existing studies

Researchers in the field of pavement management system have developed various methods for the prioritization of pavement sections for maintenance, and a few of them are discussed here. Reddy and Veeraragavan [4] developed a methodology of priority ranking which involves assigning a priority index to different sections based on their overall distress index model and traffic adjustment factors. AHP is a powerful and established prioritizing tool, a mathematical technique, which is used for multi-criteria decision making to help the decision maker in the selection of the best alternatives [5]. Ramadhan et al. [6] applied AHP technique in order to determine the priority weights of pavement-maintenance factors such as road type, pavement condition, traffic volume, riding quality of pavement, safety, maintenance cost and overall importance of the road for the community. AHP has been used in Tehran city for 131 sections to determine the priority rating of pavement maintenance while considering modeling parameters like road condition index, traffic volume and road type [7]. Almeida et al. [8] conducted a study on prioritization of maintenance of unpaved roads in the northeast region of Brazil based on AHP method, and considered a group of variables that are related to traffic, climatic, physical, management and social aspects, as modeling parameters. Farhan and Fwa [9] adopted AHP method for the prioritization of pavement activities of pavement segments having single pavement distress.

The main aim of the study was to identify an approach that can reflect the engineering judgment of highway agencies and engineers more closely. They examined three forms of AHP, namely, the distributive-mode relative AHP, the ideal-mode relative AHP and the absolute AHP. The study concluded that absolute AHP is most suitable for the pavement maintenance process. Farhan and Fwa [10] continued the same study and applied AHP method for multiple distresses in each pavement segment. In the same study the solution of priority ratings by AHP method was compared with the corresponding solution by the widely adopted PAVER pavement maintenance procedure. Shah et al. [11] proposed two methods for priority ranking of road maintenance; viz-a-viz (a) subjective rating based rank (b) economic indicator based rank. Maintenance Priority Index (MPI), a function of road condition index, traffic volume factor, special factor and drainage factor was used to obtain subjective ranking. On the other hand NPV/Cost ratio was calculated for each pavement section using HDM-4 software to obtain economic based rank. Prakasan et al. [12] developed priority ranking model for the maintenance of urban roads, using AHP method. They also developed priority ranking model using direct assessment method and compared the results with AHP model.

It is observed from the existing studies that pavement maintenance prioritization using AHP technique is subjective in nature. In AHP, experts assign the pairwise comparison to criteria and subcriteria considered in the prioritization. The criteria of a particular section does not change during the evaluation of pavement section, but the relative importance (on Saaty's scale) assigned to each parameter in the hierarchy varies between the experts (transportation professionals) consulted, which leads to discrepancies in the final rankings of the sections. Hence the process can be termed subjective. To overcome this problem the present study proposes an objective based AHP method for the evaluation of prioritization of pavement sections for maintenance. In this method, each section has been evaluated based on the collected field data. The objective of the present study is to assess the effectiveness of objective based AHP method in determining the pavement maintenance prioritization for the selected pavement sections, consisting of multiple distresses. Furthermore, the solution of priority ratings by the proposed AHP is compared with the corresponding solution by the traditional pavement maintenance procedure, the Road Condition Index (RCI) method.

## 3. Methodology of the study

This study is an attempt to apply objective based AHP method to establish the relative maintenance priorities of the pavement sections and builds up on the existing AHP methodologies to study PMS. There is a need to compare the effectiveness of this method with current methods. For a pavement evaluation study, the Pavement Condition

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