

# Chapter 8

## Analytical Hierarchy Process (AHP) based Decision Support System for Urban Intersections in Transportation Planning

**Yetis Sazi Murat**  
*Pamukkale University, Turkey*

**Ziya Cakici**  
*Pamukkale University, Turkey*

**Turan Arslan**  
*Uludag University, Turkey*

**Cengiz Akçam**  
*General Highway Directorate, Turkey*

### ABSTRACT

*In transportation planning, design of intersections is required some concrete decisions. It is mostly related to capacity, safety and economy. In many applications, capacity is considered as the main factor for design purpose and type of intersection is determined regarding the capacity. But it is known that safety and economy are as important as the capacity. In order to handle this problem, a multi-criteria decision making approach (AHP) is used. Four intersection types are used. Fuel consumption, emission rates, delay, cost of intersection type and safety parameters are taken into account in the decision process. These intersection types are tested by SIDRA Intersection software using the parameters listed above. The data obtained by SIDRA software is used in the AHP model. Weights of the factors used in the AHP model are varied considering the views of capacity and economy. And results and applicability of the model are discussed.*

### INTRODUCTION

As traffic flows from different directions at intersections, it causes crossing, merging or diverging points. Therefore, intersections must be planned and constructed with a special care. Improper planning and design may cause some important problems such as traffic accidents causing property and casualty losses, excessive delays causing congestions and fuel wastages etc.

Hence, the decision for the selection of an appropriate intersection design type is critical and one of the most important matters that decision makers face for designing efficient urban road networks.

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However, in many real world applications, particularly in developing countries, this decision has usually been taken without any analytical proof. Therefore, the outcome expected from the implementation of a particular intersection design type can be disappointing. For instance, if an intersection with low traffic volumes is designed as a signalized intersection instead of sign controlled one, then excessive delays can possibly occur and result in poor performances in other quality characteristics. On the other hand, even at intersections with high traffic volumes designed as signal controlled, still excessive delays can possibly occur, however signal controlled intersections should be preferred for considering traffic safety issues. Therefore, the decision for selecting the appropriate intersection design type involves several and sometimes conflicting criteria that decisions makers must consider. Traffic capacity, width of the lanes, number of lanes, average delay time and costs are examples of such criteria. In some cases, more than one intersection types can be suitable for a particular intersection, therefore the decision for selecting the best one is the main problem that must be tackled. Thus, an analytical approach that considers assessing multi-criteria is essential as well as the cost-benefit analysis that evaluates consequences of different intersection design types in monetary terms.

In this study, the Analytical Hierarchy Process (AHP) method is utilized as a decision support system on intersection design type selection process. A real intersection with average annual daily traffic (AADT) of 25000 vehicles in Denizli, Turkey is analyzed in this study. Four intersection design types are taken into consideration for improving the performance of the intersection; signalized without left turn bay, signalized with left turn bay, roundabout and grade-separated intersections. Fuel consumption, emission rates, delay, cost of intersection type (as construction and operation costs) and traffic safety (represented by the number of conflict points) criteria are taken into account in the decision process. The SIDRA intersection software package is utilized to obtain the performance results of each intersection design type with respect to the criteria except for the traffic safety. The AHP model is then used for assessing intersection design types with regard to all criteria including the traffic safety criterion as well. The AHP procedure, modeling stages and the SIDRA analyses are all explained in following sections.

## **THE ANALYTICAL HIERARCHY PROCESS (AHP)**

The Analytical Hierarchy Process (AHP) developed and refined by Saaty (1977; 1980; 1988; 1994) has become one of the most effective multi-criteria evaluation methods that have found uses in a wide range of practical applications in a variety of decision making processes. Since its introduction, the AHP has shown a broad impact on the field of multi-criteria or multi-attribute decision making, and recognized with its numerous applications such as choices, prioritization/evaluation, resource allocation, benchmarking and quality management, to name a few (Vaidya & Kumar, 2006). Triantaphyllou & Mann (1995) used the AHP method in industrial engineering applications and addressed some of the practical and computational issues involved. At the end of the study, they proved that the Analytical Hierarchy Process is an effective approach for this kind of decision problems. Al-Harbi (2001) studied the application of the AHP on the project management field. In the study, contractor prequalification problem was used as an example. A hierarchical structure was constructed for the prequalification criteria and the contractors wishing to prequalify for a project. By applying AHP method, contractors were prioritized. Piantanakulchai & Saengkhaio (2003) applied the AHP for the evaluation of alternatives in highway route planning and proposed it to determine the best alignment which is socially the most preferable and has the least cost. Kahraman et al., (2004) investigated the multi-attribute comparison of catering service companies

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