Prioritization of Suburban Road Safety Plans in Iran

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Abstract: Due to the high number of accidents in Iran and investigation on rate and severity of accident in Iran some safety performance indicators were intended but to implement of these indicators and limited fund in Iran we need a prioritization of these indicators in Iran to manage the usage and implementation of them to prioritize the fund consumption, severity and number of accident reduction in same time. Thus this article presents the prioritization of suburban safety performance indicator with AHP method. The Analytic Hierarchy Process (AHP) is a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales.

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1. Introduction

Road traffic injuries (RTI) are a major public health problem worldwide and a major cause of death and disability. (1) Furthermore, according to the World Health Organization, the number of road traffic deaths is expected to increase by 80% from 2000 to 2020 [Peden, 2004],[The Injury Chartbook, 2002].

Globally, road traffic injuries are ranked ninth among the leading causes of disability adjusted life years lost, and their ranking is projected to rise to third by 2020. Moreover, 96% of all children killed worldwide are due to road traffic accidents [Lyons, 2008], [Mindell, 2003].

Road traffic injuries have not always been considered a manageable or preventable health problem, [Plasència, 2003] but it has long been known that they are related to modifiable determinants. Tackling them is not substantially different from tackling other health problems. [Haddon, 1968] Actions to prevent road traffic injuries and reduce associated mortality and disability include modifying the various factors involved in collisions. These factors may play a role before, during or after a collision and may be related to the characteristics of the individuals involved, the vector that made the transfer of mechanical energy possible (e.g. the vehicle) or physical and socioeconomic circumstances. [Haddon, 1968] Several interventions have proved effective in preventing road traffic injuries. Among them are legal measures aimed at restricting driving under the influence of alcohol and at ensuring gradual access to driving licenses, as well as improvements in the design of vehicles and the road network.

The problem is increasing at a fast rate in developing countries due to rapid motorization and other factors. Road traffic injuries in developing countries particularly affect the productive age group (15–44 years) and children among whom the fatality rates are especially high. With incomplete, little or no data available from countries with higher RTI mortality rates, there is also a suggestion that the present global RTI burden is underestimated [World Health, 2002],[Kopits, 2003].

In other hand the economic and structural development of our present society is to a very large extent based on successive improvements in transport. By speeding up communications and the transport of goods and people, the transportation systems have become a crucial component of modernity, and have generated a revolution in contemporary economic and social relations. However, incorporating new technologies have not come about without cost: environmental pollution, urban stress and deteriorating air quality are all directly linked to modern transport systems. Above all, transportation is increasingly associated with the rise in the negative effects on safety, which is important not only because of the lost travel time or cost of property damage, but also because of the loss of human life and serious injuries sustained. Of all the systems with which people have to deal every day, road traffic systems are the most complex and the most dangerous with the fact that the probability of being involved in road crashes is much greater than that in all other transportation modes (rail, air, maritime, etc.). During the past decades, rapid growth of road traffic volume results in continuously increasing safety problems, such as road crashes, premature deaths, as well as physical and psychological handicaps. These not only lead up to reduced worker productivity and trauma affecting a victim's private life, but also cause great emotional and financial stress to the millions of families affected. Equally significant are the rising costs in health services and the added burden on public finances representing around 1 to 3% of the Gross Domestic Product (GDP) in most countries [WHO, 2004]. Consequently, road traffic injuries and fatalities have nowadays been recognized as one of the most important public health issues that requires concerted efforts for effective and sustainable prevention[Elke, 2000].

A high price in human and economic terms is currently being paid all over the world for motorized road mobility. Current levels and socio-economic costs of fatalities and injuries resulting from road crashes are becoming increasingly socially unacceptable and difficult to justify to citizens. Worldwide, an estimated 1.2 million people are killed in road crashes each year, and as many as 50 million more are injured [WHO, 2004]. This means that every day around the world, more than 3,000 people die from road traffic injury[Elke, 2000].

2 Projections indicate that these figures will increase by about 65% over the next 20 years unless there is new commitment to prevention [WHO, 2004].

2. Road safety performance in Iran

The growing burden of road traffic injuries, which kill over 1.2 million people yearly, falls mostly on low- and middle-income countries (LMICs). Despite this, evidence generation on the effectiveness of road safety interventions in LMIC settings remains scarce.

In 2008 according to accident and injury statistics in Iran 2 million people were disability in accident that this population is equal to one percent of Iran were injured or killed in accidents. The average cost of accident per day in 2009 in Iran was estimated 27 million dollars but if the indirect cost and social and economic losses of accident be added to this cost the overall cost of accident will be 10000 million dollars per years. According to the statistical data and economic and society feedback and limitation of infrastructure and financial source to consideration and investigation of road safety indicators in suburban area to enhance the quality level of road safety in suburban area it should be obvious that how each parameter and indicator effect on road safety. In this regard the priority of road safety indicator and allocation of fund to solve accident problems with specific budget help us to achieve best result in accident preventions plan [Mohaddese, 2010].

Due to the increasing rate of road accidents and injuries in recent years the accidents mentioned factors affecting the rate and severity of crashes are inevitable. On the other hand, due to the constraints (costs assigned) in order to improve its Factors affecting the safety of Suburban Roads, according to the priorities of each of the indicators, their classification is necessary. Using the results obtained in this study came to the following results [Mohaddese, 2010]:

- ✓ Reduce the accident rate
- ✓ reduce the severity of accidents
- ✓ Accident costs due to increased confidence and the National Roads Network...
- ✓ Identifying factors that affect crash injury severity and understanding how these factors affect injury severity is critical in planning and implementing highway safety improvement programs. Factors such as driver-related, traffic-related, environment-related and geometric design-related were considered when developing statistical models to predict the effects of these factors on the severity of injuries sustained from motor vehicle crashes at merging and diverging locations.

3. Collecting of safety parameters for Suburban Roads

Suburban Roads Safety indices for determining information requirements were collected from the regulations, ministries and various transportation departments were, of which the traffic police, the Ministry of Industry and Mines, Department of Transportation, the Department of Health and Medical science, medical education, and Red Cross and outreach organization, Ministry of Education, Ministry of Communications and Information Technology, Organization, Department of Interior and insurance, are noteworthy. According to high number of indicators and factors collected from Iran and other countries, 15 factors are presented to use in this analysis and shown in table (1) [Mohaddese, 2010].

Table 1. Road safety factors in suburban roads

No	Indicators
1	Percentage of driver using seatbelt.
2	Percentage of drivers extends the standard speed.
3	Percentage of road covered by police.
4	Average police arrival to accident.
5	Percentage of using Airbag and ABS breaks
6	Number of removed hazardous points in roads.
7	Finance allocation of roads.
8	Cost of maintenance and safety projects.
9	Percentage coverage of highway and expressway by CCTV.
10	Annual percentage of education for drivers and pedestrian.
11	Percentage coverage of road by standard medical emergency.
12	Percentage of total accidents fatality during transfer to medical centers.
13	Number of emergency vehicles per one hundred kilometer in road.
14	Average annual hours' time of training teachers and students in road safety science.
15	Average annual hour's times of TV program and Multi Media.

4. Importance of road safety management

4.1 The high cost of motorized mobility to society and public health

Each year over 1 million people are killed and 50 million injured on roads around the world. Without new and effective action, deaths in low to middle-income countries are forecast to rise steeply. At the same time, progress has slowed in recent years in the better performing countries where investment in preventing and reducing serious health loss from road traffic injury is not commensurate with its high socio-economic cost [safetynet, 2009]. This cost has been estimated at around 2% of EU countries' gross domestic product - around Euro 180 billion and twice the EU's annual budget.

4.2 Road traffic injury is largely preventable

As highlighted in the World Report on Road Traffic Injury Prevention, fatal and long term crash injury is largely predictable, largely avoidable and a problem amenable to rational analysis and remedy. Research and experience in North America, Australasia and Europe has shown that very substantial reductions in road deaths and serious injuries have been achieved through the application of evidence-based measures against the background of increased motorization [safetynet, 2009].

5. Multi-Attribute Decision Making: A General Overview

Multi-Attribute Decision Making is the most well-known branch of decision making. It is a branch of a general class of Operations Research (or OR) models which deal with decision problems under the presence of a number of decision criteria. This super class of models is very often called multi-criteria decision making (or MCDM). According to many authors (see, for instance, [Zimmermann, 1991]) MCDM is divided into Multi-Objective Decision Making (or MODM) and Multi-Attribute Decision Making (or MADM). MODM studies decision problems in which the decision space is continuous. A typical example is mathematical programming problems with multiple objective functions. The first reference to this problem, also known as the "vector-maximum" problem, is attributed to [Kuhn and Tucker, 1951]. On the other hand, MADM concentrates on problems with discrete decision spaces. In these problems the set of decision alternatives has been predetermined. Although MADM methods may be widely diverse, many of them have certain aspects in common [Chen and Hwang, 1992]. These are the notions of alternatives, and attributes (or criteria, goals) as described next [Ray, 2009].

✓ **Alternatives:**

Alternatives represent the different choices of action available to the decision maker. Usually, the set of alternatives is assumed to be finite, ranging from several to hundreds. They are supposed to be screened, prioritized and eventually ranked [Ray, 2009].

✓ **Multiple attributes:**

Each MADM problem is associated with multiple attributes. Attributes are also referred to as "goals" or "decision criteria". Attributes represent the different dimensions from which the alternatives can be viewed. In cases in which the number of attributes is large (e.g., more than a few dozens), attributes may be arranged in a hierarchical manner. That is, some attributes may be major attributes. Each major attribute may be associated with several sub-attributes. Similarly, each sub-attribute may be associated with several sub-sub-attributes and so on. Although some MADM methods may explicitly consider a hierarchical structure in the attributes of a problem, most of them assume a single level of attributes (e.g., no hierarchical structure) [Ray, 2009].

✓ **Conflict among attributes:**

Since different attributes represent different dimensions of the alternatives, they may conflict with each other. For instance cost may conflict with profit, etc.

✓ **Incommensurable units:**

Different attributes may be associated with different units of measure. For instance, in the case of buying a used car, the attributes "cost" and "mileage" may be measured in terms of dollars and thousands of miles, respectively. It is this nature of having to consider different units which makes MADM to be intrinsically hard to solve.

✓ **Decision weights:**

Most of the MADM methods require that the attributes be assigned weights of importance. Usually, these weights are normalized to add up to one [Ray, 2009].

✓ **Decision matrix:**

An MADM problem can be easily expressed in matrix format. A decision matrix A is an (M × N) matrix in which element aij indicates the performance of alternative Ai when it is evaluated in terms of decision criterion Cj, (for i = 1,2,3,..., M, and j = 1,2,3,..., N). It is also assumed that the decision maker has determined the weights of relative performance of the decision criteria (denoted as Wj, for j = 1, 2, 3,..., N). This information is best summarized in figure1. Given the previous definitions, then the general MADM problem can be defined as follows [Zimmermann, 1991]:

Definition:

Let A = { Ai, for i = 1,2,3,...,M} be a (finite) set of decision alternatives and G = {gi, for j = 1,2,3,..., N} a (finite) set of goals according to which the desirability of an action is judged. Determine the optimal alternative A* with the highest degree of desirability with respect to all relevant goals gi.

$$D = \begin{matrix} & \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} & \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{matrix}$$

Figure 1: A Typical Decision Matrix.

Very often, however, in the literature the goals gi are also called decision criteria, or just criteria (since the 3 alternatives need to be judged (evaluated) in terms of these goals). Another equivalent term is attributes. Therefore, the terms MADM and MCDM have been used very often to mean the same class of models (i.e., MADM). For these reasons, in this paper we will use the terms MADM and MCDM to denote the same concept [Ray, 2009].

6. Classifications of MCDM Methods

As it was stated in the previous section, there are many MADM methods available in the literature. Each method has its own characteristics. There are many ways one can classify MADM methods. One way is to classify them according to the type of the data they use. That is, we have deterministic, stochastic, or fuzzy MADM methods (for an overview of fuzzy MADM methods see [Chen and Hwang, 1992]). However, there may be situations which involve combinations of all the above (such as stochastic and fuzzy data) data types. Another way of classifying MADM methods is according to the number of decision makers involved in the decision process. Hence, we have single decision maker MADM methods and group decision making MADM (for more information on the later class, the interested reader may want to check the journal of Group Decision Making). In [Chen and Hwang, 1992] deterministic single decision maker -- MADM methods were also classified according to the type of information and the salient features of the information. The WSM, AHP, revised AHP, WPM, and TOPSIS methods are the ones which are used mostly in practice today and are described in later sections [Ray, 2009].

7. The AHP method

The Analytic Hierarchy Process (AHP) decomposes a complex MCDM problem into a system of hierarchies. The final step in the AHP deals with the structure of an m*n matrix (Where m is the number of alternatives and n is the number of criteria). The matrix is constructed by using the relative importance of the alternatives in terms of each criterion. Analytic Hierarchy Process (AHP) is an MCMD method based on priority theory. It deals with complex problems which involve the consideration of multiple criteria/alternatives simultaneously. Its ability to incorporate data and judgment of experts into the model in a logical way, to provide a scale for measuring intangibles and method of establishing priorities to deal with interdependence of elements in a system to allow revision of judgments in a short time to monitor the consistency in the decision-maker's judgments to accommodate group judgments if the groups cannot reach a natural consensus, makes this method a valuable contribution to the field of MCDM. The methodology is capable of Breaking down a complex, unstructured situation into its component parts, arranging these parts into a hierarchic order (criteria, sub-criteria, alternatives etc.) Assigning numerical values from 1 to 9 to subjective judgments on the relative importance of each criterion based on the characteristics Synthesizing the judgments to determine the overall priorities of criteria/sub-criteria/ alternatives Eigenvector approach is used to compute the priorities/weights of the criteria/ sub criteria/ alternatives for the given pairwise comparison matrix. In order to fully specify reciprocal and square pairwise comparison matrix, N (N-1)/2 pairs of criteria/sub criteria/ alternatives are to be evaluated. The Eigen vector corresponding to the maximum eigenvalue (λMAX) is required to be computed to determine the weight vectors of the criteria/sub-criteria/alternatives. Small changes in the elements of the pairwise comparison matrix imply a small change in λMAX and the deviation of λMAX from N is a deviation of consistency. This is represented by Consistency Index (CI). i.e. (λMAX – N)/(N-1). Randon Index (RI) is the consistency index for a randomly-filled matrix of size. Consistency ratio (CR) is the ration of CI to average RI for the same size matrix. ACR value of 0.1 or less is considered as acceptable. Otherwise, an attempt is to be made to improve the consistency ny obtaining additional information. Prof. Thomas L. Saaty (1980) originally developed the Analytic Hierarchy Process (AHP) to enable decision making in situations characterized by multiple attributes and alternatives. AHP is one of the Multi Criteria decision making techniques. AHP has been applied successfully in many areas of decision-making. In short, it is a method to derive ratio scales from paired comparisons. Four major steps in applying the AHP technique are:

1. Develop a hierarchy of factors impacting the final decision. This is known as the AHP decision model. The last level of the hierarchy is the three candidates as an alternative.
2. Elicit pair wise comparisons between the factors using inputs from users/managers
3. Evaluate relative importance weights at each level of the hierarchy
4. Combine relative importance weights to obtain an overall ranking of the three candidates.

While comparing two criteria we follow the simple rule as recommended by Saaty (1980). Thus while comparing two attributes X and Y we assign the values in the following manner based on the relative preference of the decision maker in this case the HR Managers.

Table 2. Scale Used for Pair wise Comparison

Intensity of Importance	**Definition**
1	Equal importance
3	Weak importance of one over other
5	Strong Importance
7	Demonstrated Importance
9	Absolute Importance
2,4,6,8	Intermediate Values
Reciprocals of the above	If activity i has one of the above numbers Assigned to it when compared with activity j, then j has the reciprocal value when compared with i.
1.1 – 1.9	When elements are close and nearly indistinguishable

To fill the lower triangular matrix, we use the reciprocal values of the upper diagonal. Thus we have complete comparison matrix B Estimating the Consistency for sensitivity analysis Sensitivity analysis is an extension to AHP, which is relatively unstudied. Sensitivity analysis can be useful in providing information as to the robustness of any decision. It is applicable and necessary to explore the impact of alternative priority structure for the rating of employee. The weights for the pair wise comparison were changed and it was found that the performance evaluation was also changing accordingly.

7.1 The description of AHP steps presented in three steps [Saaty, 1980].

Step 1: this step relates the comparison of the alternatives and the criteria. Once the problem has been decomposed and the hierarchy is constructed, prioritization procedure starts in order to determine the relative importance of the criteria within each level. The pairwise judgment starts from the second level and finishes in the lowest level, alternatives. In each level, the criteria are compared pairwise according to their levels of influence and based on the specified criteria in the higher level [Semih, 2007].

Following matrix (A) shows the pairwise comparison method.

Let C1, C2,..., Cn denote the set of elements, while aim represents a quantified judgment on a pair of elements, Ci and Cm. Saaty constitutes a measurement scale for pair-wise comparison. Hence, verbal judgments can be expressed by degree of preference: Equally preferred with 1, Moderately preferred with 3, Strongly preferred with 5, Very strongly preferred with 7 and Extremely preferred with 9; 2, 4, 6 and 8 are used for compromise between the above values.

$$A = [a_{im}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & 1 & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{bmatrix} \qquad i, m = 1, 2, ..., m. \tag{1}$$

Step 2: Normalize the decision matrix. Each set of column values is summed. Then, each value is divided by its respective column total value. Finally, the average of rows is calculated and the weights of the decision-maker's objectives are obtained. A set of n numerical weights w1, w2,...,wi are obtained.

Step 3: Do consistency analysis [Semih, 2007].

$$A * w_i = \lambda_{\max} * w_i , \quad i = 1, 2, ..., n. \tag{2}$$

Then consistency index (CI) is calculated as:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{3}$$

The consistency index of a randomly generated reciprocal matrix shall be called to the random index (RI), with reciprocals forced. An average RI for the matrices of order 1–15 was generated by using a sample size of 100. The table of random indexes of the matrices of order 1–15 can be seen in [Saaty, 1980]. The last ratio that has to be calculated is CR (consistency ratio). Generally, if CR is less than 0.1, the judgments are consistent, so the derived weights can be used. The formulation of CR is [Semih, 2007]:

$$CR = \frac{CI}{RI} \tag{4}$$

Compute the random index, RI, using ratio: RI = 1.98 (n-2)/n Accept the matrix if consistency ratio, CR, is less than 0.10, where CR is CR = CI / RI Consistency Ratio CR = (CI/CR) If the Consistency Ratio (CI/CR) <0.10, so the degree of consistency is satisfactory. The decision maker's comparison is probably consistent enough to be useful. Two other MCDM methods are ELECTRE and TOPSIS methods. These methods are of limited acceptance by the scientific and practitioners communities.

8. **Prepared and completed survey forms of case study.**

Statistics methods and survey implemented in this study due to lack of road accidents statistics and detailed information about the safety indicators so questioner method was done in this study. In suburban road accidents, there are two views of crashes and accidents. Therefore, in order to prepare survey forms and collect experts' data the questioners planed in two views is measured severity and number of accidents. Thus the transportation and safety experts assign a score between 1 to 17 to evaluate the effectiveness of each Index based on the two views. After fulfill the forms by experts and transportation officers all data classified and tabled like table (3) [Mohaddese, 2010].

Table 3. Indicators and collected data

No	Indicators	Rate	Severity
A1	Percentage of driver using seatbelt.	-	2
A2	Percentage of drivers extends the standard speed.	1	3
A3	Percentage of road covered by police.	4	7
A4	Average police arrival to accident.	-	15
A5	Percentage of using Airbag and ABS breaks	5	1
A6	Number of removed hazardous points in roads.	2	4
A7	Finance allocation of roads.	10	6
A8	Cost of maintenance and safety projects.	3	5
A9	Percentage coverage of highway and expressway by CCTV.	7	8
A10	Annual percentage of education for drivers and pedestrian.	6	9
A11	Percentage coverage of road by standard medical emergency.	-	13
A12	Percentage of total accidents fatality during transfer to medical centers.	-	17
A13	Number of emergency vehicles per one hundred kilometer in road.	-	16
A14	Average annual hours' time of training teachers and students in road safety science.	8	10
A15	Average annual hour's times of TV program and Multi Media.	9	11

9. Analytic hierarchy process based ranking suburban road safety performance indicator

Now we have matrix of collected data for 15 indicators that be shown in table (4). At the beginning of the first step of the calculation AHP method, pairwise comparisons matrix AHP should be prepared. This comparison has been done with experts of road safety and road traffic. This matrix is done by comparing each individual, in this matrix all index should be compared together and the value of comparison is between 1 to 9. According to the comparison in pairwise comparison matrix diagonal elements of pairwise matrix will be 1 and if the comparison between two indicators be α_{ij} the polar element under the pairwise matrix diagonal will be α_{ji} and it's equal to $1/\alpha_{ij}$. The following table (5) shows the pairwise matrix of 15 indicators.

Table 4. Collected data of matrix A

Indicators	Rate	Severity
A1	-	2
A2	1	3
A3	4	7
A4	-	15
A5	5	1
A6	2	4
A7	10	6
A8	3	5
A9	7	8
A10	6	9
A11	-	13
A12	-	17
A13	-	16
A14	8	10
A15	9	11

Table 5. Pairwise comparison matrix

Severity	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
A1	1	0.33	2	3	2	2	3	3	3	3	4	2	5	4	4
A2	3	1	3	5	3	3	4	3	2	3	4	3	4	3	3
A3	0.5	0.33	1	3	0.33	2	3	2	0.5	2	2	3	3	2	2
A4	0.33	0.2	0.33	1	0.25	0.33	0.33	0.25	0.25	0.33	1	0.33	1	0.33	0.33
A5	0.5	0.33	3	4	1	3	3	3	2	2	4	4	4	2	2
A6	0.5	0.33	0.5	3	0.33	1	2	2	0.5	3	3	3	4	0.5	0.5
A7	0.33	0.25	0.33	3	0.33	0.5	1	0.5	0.33	0.33	2	2	2	0.33	0.33
A8	0.33	0.33	0.5	4	0.33	0.5	2	1	0.33	0.5	2	3	3	0.5	0.5
A9	0.33	0.5	2	4	0.5	2	3	3	1	3	4	3	4	2	2
A10	0.33	0.33	0.5	3	0.5	0.33	3	2	0.33	1	3	3	3	1	1
A11	0.25	0.25	0.5	1	0.25	0.33	0.5	0.5	0.25	0.33	1	0.5	1	0.33	0.33
A12	0.5	0.33	0.33	3	0.25	0.33	0.5	0.33	0.33	0.33	2	1	0.5	0.33	0.33
A13	0.2	0.25	0.33	1	0.25	0.25	0.5	0.33	0.25	0.33	1	2	1	0.25	1
A14	0.25	0.33	0.5	3	0.5	2	3	2	0.5	1	3	3	4	1	1
A15	0.25	0.33	0.5	3	0.5	2	3	2	0.5	1	3	3	1	1	1
SUM	8.6	5.42	15.32	44	10.32	19.57	31.83	24.91	12.07	21.15	39	35.83	40.5	18.57	19.32

Pairwise comparison for rate also had been done as mentioned.

In step 2 the pairwise matrix will be normalized. To normalizing the pairwise comparison matrix first all values of each column will be summed and after that each value divided by sum of its columns. For example in first column and first value the normalizing will done as follow:

$$sum \text{ of column } = 1+3+0.5+0.33+0.5+0.5+0.33+0.33+0.33+0.33+0.25+0.5+0.2+0.25+0.25=8.6$$

$$Normalazing \text{ value} = \frac{\text{value}}{\text{Sume of column}} = \frac{1}{8.6} = 0.116 \tag{8}$$

Normalized matrix calculated and show in Table (6).

Table 6. Normalized Matrix

Severity	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15
A1	0.116	0.061	0.131	0.068	0.194	0.102	0.094	0.12	0.249	0.142	0.103	0.056	0.123	0.215	0.207
A2	0.349	0.185	0.196	0.114	0.291	0.153	0.126	0.12	0.166	0.142	0.103	0.084	0.099	0.162	0.155
A3	0.058	0.061	0.065	0.068	0.032	0.102	0.094	0.08	0.041	0.095	0.051	0.084	0.074	0.108	0.104
A4	0.038	0.037	0.022	0.023	0.024	0.017	0.01	0.01	0.021	0.016	0.026	0.009	0.025	0.018	0.017
A5	0.058	0.061	0.196	0.091	0.097	0.153	0.094	0.12	0.166	0.095	0.103	0.112	0.099	0.108	0.104
A6	0.058	0.061	0.033	0.068	0.032	0.051	0.063	0.08	0.041	0.142	0.077	0.084	0.099	0.027	0.026
A7	0.038	0.046	0.022	0.068	0.032	0.026	0.031	0.02	0.027	0.016	0.051	0.056	0.049	0.018	0.017
A8	0.038	0.061	0.033	0.091	0.032	0.026	0.063	0.04	0.027	0.024	0.051	0.084	0.074	0.027	0.026
A9	0.038	0.092	0.131	0.091	0.048	0.102	0.094	0.12	0.083	0.142	0.103	0.084	0.099	0.108	0.104
A10	0.038	0.061	0.033	0.068	0.048	0.017	0.094	0.08	0.027	0.047	0.077	0.084	0.074	0.054	0.052
A11	0.029	0.046	0.033	0.023	0.024	0.017	0.016	0.02	0.021	0.016	0.026	0.014	0.025	0.018	0.017

A12	0.058	0.061	0.022	0.068	0.024	0.017	0.016	0.013	0.027	0.016	0.051	0.028	0.012	0.018	0.017
A13	0.023	0.046	0.022	0.023	0.024	0.013	0.016	0.013	0.021	0.016	0.026	0.056	0.025	0.013	0.052
A14	0.029	0.061	0.033	0.068	0.048	0.102	0.094	0.08	0.041	0.047	0.077	0.084	0.099	0.054	0.052
A15	0.029	0.061	0.033	0.068	0.048	0.102	0.094	0.08	0.041	0.047	0.077	0.084	0.025	0.054	0.052

Now to determine the weights of the decision-maker the value of each row in normalized matrix will be summed and after that the average of that row will be calculated. For example the weights of the decision-maker of first row calculated as below:

$$\textit{weights} \text{ of decision maker} = \frac{\textit{sum} \text{ of row values}}{\text{numbers of columns}} = \frac{1.98}{15} = 0.132$$

(9)

All weights of decision makers have been calculated and it's shown in table (7).

Table 7. Weight of decision maker on Severity

Index	Weight
A1	0.132
A2	0.163
A3	0.074
A4	0.021
A5	0.11
A6	0.063
A7	0.034
A8	0.046
A9	0.096
A10	0.057
A11	0.023
A12	0.03
A13	0.026
A14	0.065
A15	0.06

The last step for ranking of each SPI id consistency index (CI) that calculated as:

$$A * w_i = \lambda_{\max} * w_i , \quad i = 1, 2, ..., n.$$

$$\lambda_{\max} = 9.633$$

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{9.633 - 15}{15 - 1} = -0.38$$

$$RI = 1.59$$

$$CR = \frac{CI}{RI} = \frac{-0.38}{1.59} = -0.238 \qquad \text{ranking on severity is consistent}$$

After calculation CR is less than 0.1 so the calculation and ranking is consistent. So the ranking is shown in table (8).

Table 8. Ranking of index performance on severity

Index	Ranking
A2	1
A1	2
A5	3
A9	4
A3	5
A14	6
A6	7
A15	8
A10	9
A8	10
A7	11
A12	12
A13	13
A11	14
A4	15

The ranking of performance index have done on rate of accident and shown in table (9).

$$\lambda_{\max} = 12.46$$

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{12.46 - 15}{15 - 1} = -0.18$$

$$RI = 1.59$$

$$CR = \frac{CI}{RI} = \frac{-0.18}{1.59} = -0.114 \qquad \text{ranking on amount is consistent}$$

With same procedure the AHP ranking had been done on ranking of performance index on rate of accident and the weight of decision maker is shown in table (9).The ranking of performance index on rate of accident is shown in table 10.

Table 9. Weight of decision maker on rate of accident

Index	Weight
A1	0.031
A2	0.161
A3	0.118
A4	0.021
A5	0.03
A6	0.126
A7	0.036
A8	0.058
A9	0.118
A10	0.08
A11	0.023
A12	0.023
A13	0.023
A14	0.077
A15	0.077

Table 10. Ranking of performance index on rate of accident

Index	Ranking
A2	1
A6	2
A3	3
A9	3
A10	4
A14	5
A15	5
A8	6
A7	7
A1	8
A5	9
A11	10
A12	10
A13	10
A4	11

AHP method in this paper was done on two parameters, the rate and the severity of accidents and presented to separated table but to achieved a unique ranking we can get average from this two ranking, the latest ranking in this study presented in table (11).

Table 11. Final ranking on 15 performance index

Safety Performance Index	Average of two ranking	Final Ranking
A2	0.0815	1
A9	0.162	2
A3	0.096	3
A6	0.021	4
A1	0.07	5
A14	0.0945	6
A5	0.035	7
A10	0.052	8
A15	0.107	9
A8	0.0685	10
A7	0.023	11
A12	0.0265	12
A13	0.0245	13
A11	0.071	14
A4	0.0685	15

In this research the effects of safety performance indicator on reduction of severity and rate suburban accident were identified and prioritized so with constant budget government can manage this performance to enhance the level of safety and reduce the number of accident and fatality in Iran.

According to the presented result, it can be mentioned that the percentage of drivers who extend speed limit, is the main factor that effect on severity and rate of accidents.

The second and third safety indexes in road were the percentage coverage of highway by CCTV and police so these factors are so important to decrease the rate and severity of accident in suburban road. One of the most effective measures in order to reduce the number and severity of road accidents is warranties and enforcement regulations of the road.

The next index in ranking is the number of hazardous pint in highway and then the percentage of driver use seatbelt during driving. Thus with decreasing the number of hazardous point and conflict pint in highway and roads and make a better regulations to force driver use the seatbelt the severity and rate of accident can be reduced.

Other index in this factor has an effect and impact in accident and by managing the plan and fun in road safety projects according to this ranking the result of plan and project will be better and more optimized.

Conclusion

In this article first two criterions of severity of accident and rate of accidents was selected and after that experts and transportation officers have rated the 15 safety performance of suburban road from 1 to 17 by questioners. The AHP method was the next step to prioritize the factors.by implementation of AHP method two ranking table were obtained those one of them was based on severity and another one was based on rate of accident but to have a unique ranking we have gotten averaging from two ranking and last ranking was obtained. In last ranking the percentage of driver who extends the standard speed was the first factor and the last factor was the average arrival time of police to accident. Thus we can manage those entire safety performance indicator according to last ranking based on AHP method to optimize the finance and time in our plans.

All this information could be used to make the population aware of its own risk for road accidents. Linkage of these data with police and transport data is required to focus prevention on higher risk groups and to adopt effective local road safety strategies.

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