Investigation of Road Accidents and Casualties Factors with MCDM Methods in Iran

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Abstract: In a sufficient transportation system, traffic safety is an important parameter and it is influenced by many factors. There are many policies in countries with different financial source and road infrastructure but in a country like Iran, until now safety performances are mainly concentrated on road engineering activities, without much attention for vehicle technology or driving behavior and precautionary planes. One important aspect of road safety engineering activities is road performance management in roads and accident management after events. Thus this paper presents the prioritization of some factors those can affect on reduction of accident issue aspect of rate and severity. To do this, the simple additive weighting has been adopted and a prioritization model is produced by the use of a "Multiple Criteria Decision Making" (MCDM) method. The procedure is illustrated on 15 different safety factors in Iran. In addition, the averaging concept will used to compare three MCDM methods (AHP, SAW and TOPSIS) to determine which method is appropriate method to use in this prioritization plan.
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1. Introduction

Road traffic collisions are a major cause of premature death and disability worldwide: every year, 20 to 50 million people involved in collisions are injured and around 1.3 million die.[Peden, 2004] In particular, road traffic injuries are the main cause of death among adolescents and young adults.[patton, 2009[The World Health Organization (WHO) estimates that death from road traffic injuries will become the fifth leading cause of death worldwide in 2030;[Word, 2008] in 2004, it was the ninth.[European, 2009] Although 90% of these deaths are concentrated in low- and middle-income countries, road traffic collisions in WHO's European Region cause at least 120 000 deaths and injure 2.4 million people each year. [European, 2009]

Road traffic injuries have not always been considered a preventable health problem,[Plasencia, 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 licences, as well as improvements in the design of vehicles and the road network.[Novoa, 2009]

In addition to their social and epidemiological effects, road traffic injuries also have substantial economic implications: they lead to increased direct and indirect costs and to losses in productivity. The annual cost of road traffic collisions has been estimated for different areas of Spain: it was 1586 million euros (€) in the northwestern region of

Galicia in 2003, €240 million in the Canary Islands in 1997, €9039 million in the whole of Spain in 2004, €144 million in the whole of Catalonia in 2007 and €367 million in the Catalan capital Barcelona in 2003.[Pereira, 2007],[Gracia, 2011] The literature reports that the cost of road traffic collisions lies between 0.5% and 2.3% of a country's gross domestic product.[Naumann, 2005],[Finkelstein, 2006]

In the course of the twentieth century road traffic injuries (RTIs) became a major public health burden. RTI deaths first increased in high-income countries and declined after the 1970s, and they soared in low- and middle-income countries from the 1980s onwards.

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.

A larger proportion of rural trauma victims die at the scene of injury, which is credited to longer discovery, response, and transport times [Gonzalez, 2006],[Carr, 2006]

The transportation and mainly road safety is one of important issues for Islamic Republic of Iran's planners , because of its high degree of urbanization (about 65%), its large and mountainous land area, the long distances between large cities, and its privileged location at the crossroads of international trade routes. With about 81000 Km of main and regional roads (95% paved), 7,265 Km of railway lines, four main ports on the Persian Gulf and three on the Caspian Sea, and seven international airports, Islamic Republic of Iran enjoys a well-developed transport network [Zekavat, 2006].

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.

Road crash and injury rates in the Iran have been affected substantially by social and economic developments during a period of dramatic change in the last decade. This has been a period of huge administrative and financial upheaval and reform, during which there have been significant hangs in the rule and public perception of the law. Car ownership more than doubled putting enormous strain on the existing network, car occupant and goods transit, the health sector and society at large. Iran is faced with considerable and difficult challenges in bringing its serious road safety situation under control as a result of this recent history.

According to road safety standards in word, the current situation in Iran is indeed among the worst worldwide. For instance, in 1995, around 10000 road fatalities and more than 50000 injuries were reported. Only 5 years later, more than 15000 people died and more than 87000 were injured in traffic accidents in Iran [Montazeri, 2004] and the problem is still increasing. Whereas most western countries experienced a continuous decline in the number of road fatalities during the past decades, the number of road accident fatalities and injuries in Iran has incline to respectively 30000 and 285000 in 2006. Given that the population of Iran was 66360000 in 2000 and around 70 000 000 in 2006 [Globalis, 2008], the rate of road accident fatalities increased from 22.6 to 42.9 per 100 000 inhabitants. Analysis at local level, permits to estimate the burden of injuries caused by road-traffic, to describe the characteristics of injured persons and finally to estimate costs of care. 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.

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.

2. Implementation of MCDM methods and case study

In this case study engineers attempt to understand and investigation of road safety indicators and prioritization of them based on their effectiveness on two factors means severity and amount of accident in suburban roads. In this study first the road safety indicators and index in different country investigated and after those authors had provided numbers of questioner to verify the effectiveness of each factor on those parameters and after that these questioners were full fill with some of experts of road safety in Iran. These questioners were based on effectiveness of those indicators on amount and severity of road accident. After that data collection was done with data mining from this questioner and after that those indicators were ranked by MCDM methods. The following table 1 shows the several factors that should be prioritized in this study.

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7. Multi Criteria Decision making

Road safety managers are faced with decision environments and safety problems in road safety performance that are complex. The elements of the problems are numerous, and the inter relationships among the elements are complicated. Relationships between elements of a problem may be highly nonlinear; changes in the elements may not be related by simple proportionality. Furthermore, human value and judgments systems are integral elements of safety problems [Lifson, 1982]. Therefore, the ability to make sound decisions is very important to the success of a project. In fact, Schuyler [Schuyler, 1996] makes it a skill that is certainly near the top of the list of safety management skills.

Multiple criteria decision-making (MCDM) approaches are major parts of decision theory and analysis. They seek to take explicit account of more than one criterion in supporting the decision process [Belton, 1990]. The aim of MCDM methods is to help decision-makers learn about the problems they face, to learn about their own and other parties' personal value systems, to learn about organizational values and objectives, and through exploring these in the context of the problem to guide them in identifying a preferred course of action [Belton, 1990; Russel, 1990; Von Winterfeldt, 1986; Watson, 1987]. In other words, MCDA is useful in circumstances which necessitate the consideration of different courses of action, which cannot be evaluated by the measurement of a simple, single dimension [Belton, 1990].

Hwang and Yoon [Hwang, 1981] published a comprehensive survey of multiple attribute decision making methods and applications. Two types of the problems that are common in the road safety project management that best fit MCDA models are evaluation problems and design problems. The evaluation problem is concerned with the evaluation of, and possible choice between, discretely defined alternatives. The design problem is concerned with the identification of a preferred alternative from a potentially infinite set of alternatives implicitly defined by a set of constraints [Belton, 1990].

8. AHP Method

The analytic hierarchy process (AHP) pioneered in 1971 by Saaty [Saaty, 1980] is a widespread decision-making analysis tool for modeling unstructured problems in areas such as political, economic, social, and management sciences. Based on the pair-by-pair comparison values for a set of objects, AHP is applied to elicit a corresponding priority vector that represents preferences. Since pairwise comparison values are the judgments obtained using a suitable semantic scale, it is unrealistic to expect that the decision-maker(s) have either complete information or a full understanding of all aspects of the problem [Boender, 1989; Buckly, 1985; Chang, 1996; Dong, 1989; Haines, 1998; Kumar, 1996; Laarhoven, 1983; Levary, 1998; Nurmi,1981].

Saaty [Saaty, 1990] developed the following steps for applying the AHP:

1. Define the problem and determine its goal.
2. Structure the hierarchy from the top (the objectives from a decision-maker's viewpoint) through the intermediate levels (criteria on which subsequent levels depend) to the lowest level which usually contains the list of alternatives.
3. Construct a set of pair-wise comparison matrices(size n _ n) for each of the lower levels with one matrix for each element in the level immediately above by using the relative scale measurement shown in Table 1. The pair-wise comparisons are done in terms of which element dominates the other.
4. There are n(n – 1)/judgments required to develop the set of matrices in step 3. Reciprocals are automatically assigned in each pair-wise comparison.
5. Hierarchical synthesis is now used to weight the eigenvectors by the weights of the criteria and the sum is taken over all weighted eigenvector entries corresponding to those in the next lower level of the hierarchy.
6. Having made all the pair-wise comparisons, the consistency is determined by using the eigenvalue, $\lambda_{\max}$, to calculate the consistency index, CI as follows: $CI = \frac{\lambda_{\max} - n}{n-1}$, where n is the matrix size. Judgment consistency can be checked by taking the consistency ratio (CR) of CI with the appropriate value in Table 2. The CR is acceptable, if it does not exceed 0.10. If it is more, the judgment matrix is inconsistent. To obtain a consistent matrix, judgments should be reviewed and improved.
7. Steps 3-6 are performed for all levels in the hierarchy.

Table 1. Pair-wise comparison scale for AHP preferences

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

According to the factors were mentioned above the transportation expert had done the full fill of questioners and table 2 shows the value of severity and rate of accident that affected by factors.

According to the AHP procedure the AHP method was applied for these factors the final ranking is shown in table 3.

In table 3 the ranking of 15 safety indicator were shown according to two index’s, rate and severity of accident. So we can check that in suburban area the major factor that effects of accidents in the drivers who pass the standard speed in highways and the second one is the percentage of highway that control by CCTV in Iran and it means that the result and accident data show that with controlling the speed and driver behavior in suburban highway we can reduce the rate and severity of accident. According to the last ranking index we can see that the average arrival time of police is not insufficient factor to reduce rate or severity of accidents. In following we can see the ranking of these indicators based on TOPSIS method.

Table 2. 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

Table 3. 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

9. TOPSIS Method

TOPSIS, developed by Hwang and Yoon in 1981, is a simple ranking method in conception and application. The standard TOPSIS method attempts to choose alternatives that simultaneously have the shortest distance from the positive ideal solution and the farthest distance from the negative-ideal solution. The positive ideal solution maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. TOPSIS makes full use of attribute information, provides a cardinal ranking of alternatives, and does not require attribute preferences to be independent [Chen and Hwang, 1992; Yoon & Hwang, 1995]. To apply this technique, attribute values must be numeric, monotonically increasing or decreasing, and have commensurable units. Fig. 1 presents the stepwise procedure of Hwang and Yoon (1981) for implementing TOPSIS. After forming an initial decision matrix, the procedure starts by normalizing the decision matrix. This is followed by building the weighted normalized decision matrix in Step 2, determining the positive and negative ideal solutions in Step 3, and calculating the separation measures for each alternative in Step 4. The procedure ends by computing the relative closeness coefficient. The set of alternatives (or candidates) can be ranked according to the descending order of the closeness coefficient.

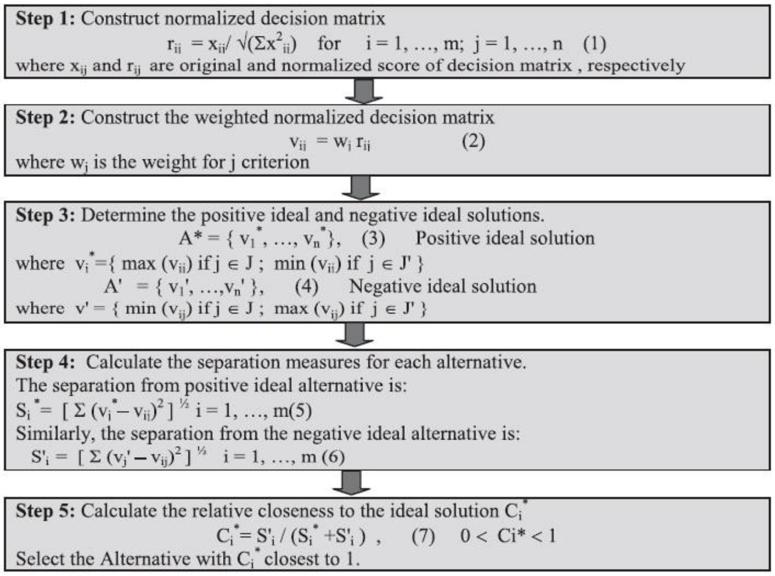

Fig. 1. Stepwise procedure for performing TOPSIS methodology.

Now according to Topsis method the result of this method will be presented as follow table 4.

Table 4. Ranking of indicators based on Topsis method

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

This ranking shows the different type of ranking in MCDM methods. In this ranking the first factor that its more effective in rate and severity of accident is the drivers with passed standard speed that is same with AHP method, the second factor is percentage of using airbag and ABS break that it means with using airbag and ABS break we can reduce the severity of accident but not rate of accident, and the third one is percentage of driver using seatbelt but this one is also jus can effect or severity of accident not rate of accident and the last indicator is percentage of total accident fatality during transfer to medical centers.

9.1. SAW Method

9.1.1. Entropy Shanon Method

Entropy is a method for assessment of weights of decision matrix attributes which seems to be a major concept in physical and social sciences and also in the information theory where it measures the expected information content of a certain message [Chu, 2007]. In other words, in information theory, Entropy is a criterion for determination of the degree of unreliability of a discrete probability distribution P_i in such a way that this unreliability in biased distributions is more than sharper distributions [Chu, 2007].

This unreliability is demonstrated as follows [Podvezko, 2010]:

$$E_i = S(P_1, P_2, \ldots, P_n) = -K \sum P_i Ln\, P_i \qquad (i = 1, 2, 3, \ldots, m) \qquad (1)$$

Such that k is a positive constant to fulfill $0 \le E_i \le 1$.

E is computed from the probability distribution P_i based on a statistical mechanism and its amount will be maximum if P_i are equal with each other $P_i = \frac{1}{n}$.

A decision matrix contains information which can be evaluated via Entropy technique. Now consider a decision matrix below:

$$D = \begin{matrix} & X_1 & X_2 & \cdots & X_n \\ A_1 & r_{11} & r_{12} & \cdots & r_{1n} \\ A_2 & r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ A_m & r_{m1} & r_{m2} & \cdots & r_{mn} \end{matrix} \quad (2)$$

Elements $(P_{ij})j$ of this matrix are initially calculated as follows:

$$P_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \quad ; \mathrm{j}=1,\ldots,\mathrm{n}\ \forall_{\mathrm{ij}} \quad (3)$$

For E_j from the set P_{ij} for any attribute we have:

$$E_j = -K \sum_{i=1}^{m} P_{ij}.Ln(P_{ij}) \quad \mathrm{j}=1,\ldots,\mathrm{n}\ \forall_j \quad (4)$$

K represents a constant $K = \frac{1}{Ln(m)}$ which guarantees that $0 \le E_j \le 1$

Now the degree of unreliability or the same degree of deviation from constructed information d_j for the attribute *J* is as follows:

$$d_j = 1 - E_j \ , \forall_{\mathrm{j}} \quad (5)$$

Eventually, in order to calculate the weight of each attribute *J* we have:

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} , \forall_{\mathrm{j}} \quad (6)$$

In a case that decision maker has a subjective judgment λ_j as a relative importance for the attribute J, and then the calculated w_j can be adjusted via Entropy as below [Farimah, 2012]:

$$W_j = \frac{\lambda_j w_j}{\sum_{j=1}^{n} \lambda_j w_j} , \forall_{\mathrm{j}}$$

9.1.2. Simple additive weight

The Simple Additive Weighting method (SAW) is probably the best known and widely used method of Multiple Attribute Decision Making. To each of the attributes in SAW the decision maker assigns importance weights, which become the coefficients of the variables. These weight coefficients need to be normalized. To reflect the decision maker's marginal worth assessments within attributes, the decision maker also makes a numerical scaling of intra-attribute values. The decision maker can then obtain a total score for each alternative simply by multiplying the scale rating for each attribute value by the importance weight assigned to the attribute and then summing these products over all attributes. After the total scores are computed for each alternative, the alternative with the highest score (the highest weighted average) is the one prescribed to the decision maker [Podvezko,2010].

As a given W and a sufficient factor A^*, thus A^* will be obtained as bellow [Jakimavicius, 2009]:

$$A^* = \{A_i | \max_i \frac{\sum_{j=1}^{n} W_j r_{ij}}{W_j} \} \quad (8)$$

If $\sum W_j = 1$ then A^* equal to:

$$A^* = \{A_i | \max_i \sum_{i=1}^{n} W_j r_{ij} \} \quad (9)$$

Now according to the formula the matrix of weight is calculated and it's shown in table 4.

Table 4. Matrix of weights

ALTERNATIVES	Severity	Rate
A1	0.047	0.313
A2	0.071	0.028
A3	0.166	0.114
A4	0.355	0.313
A5	0.023	0.142
A6	0.094	0.057
A7	0.142	0.28
A8	0.118	0.085
A9	0.189	0.199
A10	0.213	0.171
A11	0.308	0.313
A12	0.33	0.313
A13	0.28	0.313
A14	0.403	0.313
A15	0.38	0.313
A16	0.237	0.228
A17	0.261	0.256

In this table 4 the value of each indicator and its effect on severity and rate of accident were calculated according to the questioner.

Now to calculate the K value:

$$K = \frac{1}{Ln(m)} = \frac{1}{Ln(15)} = 0.396$$

And according to formula 6 the matrix of W_j is calculated and shown in below:

$$W_j \begin{bmatrix} 0.0592 \\ 0.0418 \end{bmatrix}$$

And after this step the final ranking based on rate and severity will be calculated that it's shown in table 5.

Table 5. Final Ranking Based on SAW method

Indicators	SAW	Ranking
A2	0.005374	1
A5	0.007297	2
A6	0.007947	3
A8	0.010539	4
A3	0.014592	5
A1	0.015866	6
A9	0.019507	7
A10	0.019757	8
A7	0.02011	9
A14	0.023561	10
A15	0.026152	11
A11	0.031317	12
A4	0.034099	13
A13	0.035579	14
A12	0.036941	15

In this ranking we can see that the first indicator is the drivers who pass the standard speed same with other ranking and the second one is the percentage of drivers use Airbag and ABS break. And the third one is number of removed hazardous point on road and the last one is percentage of accident fatality during the transfer to the medical center.

10. Implementation of averaging concept

In this step to determine which method is appropriate method in case of using in this safety management the averaging concept will be used. First the average value of indicators in each method will calculate and then the difference between each indicator in method will be calculated the difference off each method with average is:

$$\Delta_1 = Average - SAW \qquad (10)$$

$$\Delta_2 = Average - AHP \qquad (11)$$

$$\Delta_3 = Average - TOPSIS \qquad (12)$$

Table 6 shows the difference and average difference of each method. Now to determine which method is the sufficient method to use is safety management the average of delta which is closer to zero is the best method so according to table 6, Δ_2 is 0.097 and its closer value to zero, thus its determined as an appropriate method in MCDM to rank and prioritize the safety indicator in safety management.

Table 6. Difference and average of methods

Indicator	SAW	AHP	TOPSIS	Average	Δ_1	Δ_2	Δ_3
A1	0.016	0.070	0.637	0.241	0.225	0.171	-0.396
A2	0.005	0.082	0.890	0.326	0.320	0.244	-0.564
A3	0.015	0.096	0.511	0.207	0.193	0.111	-0.304
A4	0.034	0.069	0.107	0.070	0.036	0.002	-0.037
A5	0.007	0.035	0.643	0.229	0.221	0.194	-0.415
A6	0.008	0.021	0.607	0.212	0.204	0.191	-0.395
A7	0.020	0.023	0.568	0.204	0.183	0.181	-0.364
A8	0.011	0.069	0.576	0.218	0.208	0.150	-0.358
A9	0.020	0.162	0.453	0.211	0.192	0.049	-0.241
A10	0.020	0.052	0.424	0.165	0.146	0.113	-0.259
A11	0.031	0.071	0.209	0.104	0.072	0.033	-0.105
A12	0.037	0.027	0.000	0.021	-0.016	-0.005	0.021
A13	0.036	0.025	0.052	0.037	0.002	0.013	-0.015
A14	0.024	0.095	0.052	0.057	0.033	-0.038	0.005
A15	0.026	0.107	0.312	0.149	0.122	0.042	-0.164
-	-	-	-	**SUM**	2.142	1.450	-3.591
-	-	-	-	**AVERAGE**	0.143	0.097	-0.239

11. Conclusion

In this article prioritization of road safety factor to achieve optimization of road safety performance management and also prioritization of safety factors to performance and operating management with restricted finance source have been done with three methods of AHP, FUZZY TOPSIS and SAW method. In base of three methods we obtained three kind of ranking with different prioritization but to achieve the best ranking and determine which method is sufficient method in this management we have used the average concept to determine which method is the best. After implementation of averaging concept in this article it was cleared that the AHP method is the best method in term of prioritization of suburban road safety indicator to manage the factors to decrease the number of accident and also the severity of accidents in Iran.

References

1. Belton V. Multiple criteria decision analysis Ð practically the only way to choose. In: Hendry LC, Eglese RW, editors. Operational research tutorial papers. 1990, pp. 53-102.
2. Boender CGE, de Graan JG, Lootsma FA. Multi-criteria decision analysis with fuzzy pairwise comparisons. Fuzzy Sets and Systems 1989;29:133–43.
3. Buckly JJ. Fuzzy hierarchical analysis. Fuzzy Sets and Systems 1985;17:233–47.
4. Chang DY. Applications of the extent analysis method on fuzzy AHP. European Journal of Operational Research 1996;95:649–55.
5. Chen, S. J., & Hwang, C. L. (1992). Fuzzy multiple attribute decision making: Methods and applications. Berlin: Springer-Verlag.
6. Chu, MT., Shyu, J., Tzeng, GH., & Khosla, R. (2007). Comparison among three analytical methods for knowledge communities group-decision analysis. Expert systems with applications, 33(4), 1011-1024.
7. Dong WM, Wong FS. Interactive fuzzy variables and fuzzy decisions. Fuzzy Sets and Systems 1989;29:1–19.
8. Dyer JS, Wendel RE. A critique of the analytical hierarchy process. Working Paper 84/85-4-24, Department of Management, the University of Texas at Austin, 1985.
9. Haines LM. Astatistical approach to the analytic hierarchy process with interval judgements. European Journal of Operational Research 1998;110:112–25.
10. Hwang CL, Yoon K. Multiple attribute decision making: Methods and applications: A-State-of-the-Art Survey. Berlin: Springer-Verlag, 1981.
11. Globalis - an Interactive World Map (2008) UN common database, http://globalis.gvu.unu.edu/indicator_detail.cfm?Country=IR&IndicatorID=132.
12. Jakimavicius, M., & Burinskiene, S. (2009). A GIS and multi-criteria-based analysis and ranking of transportation
13. zones of Vilnius citi. Technological and Economic Development of Economy, 15(1), 39-48.
14. Kumar NV, Ganesh LS. An empirical analysis of the use of the analytic hierarchy process for estimating membership values in a fuzzy set. Fuzzy Sets and Systems 1996;82:1–16.
15. Levary RR, Wan K. Asimulation approach for handling uncertainty in the analytic hierarchy process. European Journal of Operations Research 1998;106:116–22.
16. Lifson MW, Shaifer EF. Decision and risk analysis for construction management. New York: Wiley, 1982.
17. Montazeri, A. (2004) Road-traffic-related Mortality in Iran: a Descriptive Study, Journal of The Royal Institute of Public Health, 118(2), pp. 110-113.
18. Nurmi H. Approaches to collective decision making with fuzzy preference relations. Fuzzy Sets and Systems 1981;6:249–59.
19. Perez J. Some comments on Saaty's AHP. Management Science 1995;41(6):1091-5.
20. Podvezko, V., & Podviezko, A. (2010). Dependence of multi-criteria evaluation result on choice of preference functions and their parameters. Technological and Economic Development of Economy, 16(1), 143-158.
21. Russell JS. Surety bonding and owner-contractor prequali®cation: comparison. Journal of Professional Issues in Engineering, ASCE 1990;116(4):360-74.
22. Saaty, T.L. (1980) The Analytic Hierarchy Process, McGraw- Hill, New York.
23. Saaty TL. Decision making for leaders. Belmont, California: Life Time Leaning Publications, 1985.
24. Saaty TL. How to make a decision: the analytic hierarchy process. European Journal of Operational Research, North-Holland 1990;48:9-26.
25. Saaty, T.L. (2000) Fundamentals of Decision Making and Priority Theory with the AHP, RWS Publications, Pittsburg.
26. Schuyler JR. Decision analysis in projects. Upper Darby, PA,USA: Project Management Institute, 1996.
27. van Laarhoven PJM, Pedrycz W. Afuzzy extension of Satty's priority theory. Fuzzy Sets and Systems 1983;11:229–41.
28. Von Winterfeldt D, Edwards W. Decision analysis and behavioral research. Cambridge: Cambridge University Press, 1986.

29. Watson SR, Buede DM. Decision synthesis: the principles and practice of decision analysis. Cambridge: Cambridge University Press, 1987.
30. Yoon, K. P., & Hwang, C. L. (1995). Multiple attribute decision making. Thousand Oaks, CA: Sage Publication.
31. Zekavat, S. (2006) Road Safety - Government Policy, Expert Group Meeting on the Development of the Asian Highway Network: Regional Experiences and Lessons in Financial Highway Infrastructure and Improving Road Safety, 8-10 May, Bangkok.
32. Peden M, Scurfield R, Sleet D, Mohan D, Hyder AA, Jarawan E et al. editors. *World report on road traffic injury prevention*Geneva: World Health Organization; 2004.
33. Patton GC, Coffey C, Sawyer SM, Viner RM, Haller DM, Bose K, et al. Global patterns of mortality in young people: a systematic analysis of population health data. Lancet. 2009;374:881–92. doi: 10.1016/S0140-6736(09)60741-8.
34. *World Health Statistics 2008*Geneva: World Health Organization; 2008. Available from: http://www.who.int/whosis/whostat/2008/en/index.html [accessed 15 November 2012].
35. *European status report on road safety: towards safer roads and healthier transport choices.*Copenhagen: World Health Organization Regional Office for Europe; 2009.
36. Plasència A, Cirera E. Accidentes de tráfico: Un problema de Salud a la espera de una respuesta sanitaria [Traffic accidents: a health problem waiting for sanitary response]. Med Clin (Barc) 2003. 120378–9.9Spanish. doi: 10.1157/13044732.
37. Haddon W., Jr The changing approach to the epidemiology, prevention, and amelioration of trauma: the transition to approaches etiologically rather than descriptively based. Am J Public Health Nations Health. 1968;58:1431–8. doi: 10.2105/AJPH.58.8.1431.
38. Novoa AM, Pérez K, Borrell C. Efectividad de las intervenciones de seguridad vial basadas en la evidencia: una revisión de la literatura [Evidence-based effectiveness of road safety interventions: a literature review]. Gac Sanit 2009. 23553.e1–e14.e14Spanish.
39. Pereira R. Aspectos socioeconómicos dos accidentes de tráfico en Galicia. Revista Galega de Economía 2007. 161–20.20Galician.
40. García-Altés A, Puig-Junoy J. What is the social cost of injured people in traffic collisions? An assessment for Catalonia. J Trauma. 2011;70:744–50. doi: 10.1097/TA.0b013e3181eaaa5b.
41. Naumann RB, Dellinger AM, Zaloshnja E, Lawrence BA, Miller TR. Incidence and total lifetime costs of motor vehicle-related fatal and nonfatal injury by road user type, United States, 2005. Traffic Inj Prev. 2010;11:353–60. doi: 10.1080/15389588.2010.486429.
42. Finkelstein EA, Corso PS, Miller TR et al. *The incidence and economic burden of injuries in the United States.*New York: Oxford University Press; 2006.
43. Gonzalez RP, Cummings G, Mulekar M, Rodning CB. Increased mortality in rural vehicular trauma: identifying contributing factors through data linkage. J Trauma. 2006;61:404–409. doi: 10.1097/01.ta.0000229816.16305.94.
44. Carr BG, Caplan JM, Pryor JP, Branas CC. A meta-analysis of prehospital care times for trauma. Prehosp Emerg Care. 2006;10:198–206. doi: 10.1080/10903120500541324.

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