

REVIEW OF CONTRIBUTING FACTORS IN ROAD TRAFFIC ACCIDENTS IN IRAN

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ABSTRACT

Road traffic accident is generally considered as a multilateral event in which one or more road users are not able to cope with circumstances and it results in fatal or financial damages. Occurrence of many accidents is predictable. Hence, factors with potential of accident occurrence can be identified, many similar accidents can be prevented or their severity can be reduced by using appropriate measures. In this paper, previous studies on the contributing factors in the formation of accidents are reviewed; while the share of each factor in occurrence of accident is estimated. Based on the results of this study, the role of human factor cannot be intended as the major accident contribution factor and the other factors leading road users to make the mistakes such as road environment, vehicles and their interactions with the human factor should be considered. Apart from the belief that the share of human factor in road accidents is 90 percent, it must be admitted that the environment, road conditions, traffic combination and vehicles have a significant role in the formation of accidents.

1. INTRODUCTION

Road traffic accident is generally considered as a multilateral event in which one or more road users are not able to cope with circumstances and it results in fatal or financial damages. Upon the experts' view, Occurrence of many accidents is predictable. Hence, factors with potential of accident occurrence can be identified, many similar accidents can be prevented or their severity can be reduced by using appropriate measures. The first step to present the measures for road safety improvement is identifying the accident occurrence factors and their interactions. In this paper, by literature review in determination traffic accidents factors, the share of contributing factors in road traffic accident in Iran is estimated.

2. CONTRIBUTING FACTORS IN ROAD TRAFFIC ACCIDENTS

In general, for traffic accident occurrence cycle, three factors including human, vehicle and road and the environment are considered. Expected characteristics of these factors which were presented by Haddon's matrix is shown in table 1. In fact, this matrix states the need of existing special characteristics of these three factors at three phases including before, during and after the accident and provision of these characteristics causes proper interaction between these factors and reduces traffic accidents and relating damages.

Table1- Contributing factors in road traffic accidents- Haddon matrix [1]

System	Before the accident	During the accident	After the accident
Human	<p>Physical condition</p> <ul style="list-style-type: none"> -fatigue, illness, medication, alcohol -Handicaps: sight, hearing, etc. <p>Physiological condition</p> <ul style="list-style-type: none"> -stress, inattention, distraction, attitude <p>Socio- demographic profile</p> <ul style="list-style-type: none"> -age, sex, professional occupation, level of education <p>Experience and skill</p> <ul style="list-style-type: none"> -driving experience, knowledge of vehicle and itinerary, knowledge of regulation and action <p>Maneuvers before collision</p> <ul style="list-style-type: none"> self- protection -seatbelt, helmet 	<p>Physical condition</p> <ul style="list-style-type: none"> - reflex <p>Error</p> <ul style="list-style-type: none"> - poor mental image of the road - poor evaluation of distances and speeds <p>-inappropriate maneuvers</p> <p>action</p> <ul style="list-style-type: none"> -speed -braking -positioning - warning 	<p>Physical condition</p> <ul style="list-style-type: none"> -resistance to impact <p>Physiological condition</p> <ul style="list-style-type: none"> - emotional shock <p>Experience and skill</p> <ul style="list-style-type: none"> - safety list -protection of accident- scene - raising the alarm <p>Action</p> <ul style="list-style-type: none"> - maneuvers after collision
Vehicle	<p>Physical factors</p> <ul style="list-style-type: none"> -type and make, colour, horsepower mechanical condition - Brakes, tires, suspension, lights, etc. <p>Damage</p> <ul style="list-style-type: none"> -external, internal <p>Running state</p> <ul style="list-style-type: none"> -objects, position of passenger <p>Obstructive luggage</p>	<p>Activation of passive safety</p> <ul style="list-style-type: none"> - resistance of deformation <ul style="list-style-type: none"> -airbag -mayday 	<p>Handling of damaged vehicles</p>
Road Environment	<p>Geometry</p> <ul style="list-style-type: none"> - vertical alignment, cross-section, horizontal alignment <p>Surface characteristics</p> <ul style="list-style-type: none"> -skid resistance, roughness - debris, contamination <p>Surrounding</p> <ul style="list-style-type: none"> - urban, rural - advertising, shops - traffic volume - main users <p>Equipment</p> <ul style="list-style-type: none"> - signs, markings, etc. 	<p>Recovery area:</p> <ul style="list-style-type: none"> -shoulders, emergency lane <p>- central refuge</p> <p>Roadside conditions</p> <p>Critical zone</p> <ul style="list-style-type: none"> - transition zone -workzones, unusual surroundings defect - maintenance - obstacle on roadway 	<p>Accident warning</p> <p>cleaning up the road</p>

2.1. Human Factor

Human factor is the main factor in many road traffic accidents involving single vehicle accidents or multi- vehicle collisions. Physical and Physiological condition and behavioral characteristics of driver are very affecting before accident occurrence in four phases including data collecting, analyzing, making decision and acting. Some of these conditions and characteristics are inattention, distraction, fatigue, alcohol, drug, speeding, offense against traffic regulation [2].

In investigating human error in driving, it is necessary to distinguish between conscious and unconscious errors. The most errors are unconscious. Upon the research done by FHWA the main factor in more than 75% of traffic accidents is unconscious errors such as inattention and distraction [3]. Also, the road condition and the environment including access ways, traffic combination, illegible alignment and unpredictable condition in road have a significant role in road traffic accident occurrence. Reducing human errors requires engineering measures, enforcement of obstructive regulation and effective education.

2.2. Vehicle Factor

Vehicle safety has a significant role in road traffic accidents reduction both in pre and post accident phases which are known as active and passive safety, respectively (table 1). For example the friction between the road surface and the tire of vehicle is very important in timely vehicle stop or prevention of run-off or collision with other vehicles or obstructions. As determination of contributing roles of different parts of a vehicle in road traffic accident is very complicated and needs expertise, mainly this contribution share of vehicle, is determined incorrectly and only is limited to the obvious malfunction such as tire blowing and brake fading. For modification of this approach and designation the role of vehicle factor beside human errors, the extensive effort should be done.

2.3. Road and the Environment Factor

Road and its environment defects are the significant factors in road traffic occurrence beside human errors. In the countries which are in primary phases of road traffic safety management, the road share is determined without consideration of human errors or vehicle malfunction and is estimated about 5%. But according to the studies, the road and its environment factor in more than 50% of road traffic accidents, is the cause of road traffic accidents beside human factor and vehicle.

Road factor includes various parameters as road physical condition, traffic volume and combination, roadside condition such as secondary roads access and land use. A safe road should provide proper interaction with human and vehicle factors. The interaction between road and vehicle is provided through level surface, enough friction, proper super elevation in curves and appropriate radius according to speed. In fact, the most important factor in road safety provision is the interaction between the road and human as road user. This interaction is achieved through provision of five road characteristics including: 1) self- explaining that means legible and predictable road, 2) forgiving that means safe roadside provision, 3) preventive of dangerous maneuvers, 4) provision of required space for various maneuvers in road, 5) provision safety for all groups of road users such as pedestrians, cyclist, motorcyclist and slow vehicle drivers. In developing countries these five characteristics are generally neglected. In developed countries, the effectiveness of road physical improvement in

comparison with vehicle and human behavior amelioration, is two times more which shows the important role of road and its environment.

3. EVOLUTIONARY TREND OF EXISTING ASPECTS IN ROAD TRAFFIC ACCIDENTS CAUSES

A short view to the complementary trend of road traffic accidents aspects and studies about accidents contributing factors identifies six different aspects as following [3]:

3.1. Single Contributing Factor: Due to Human Error

Upon this aspect, the main cause of accident is single and is due to the human error in thinking and making decisions. In this aspect the driver is to blame and the interactions between the system components are neglected and results investigation is ineffective.

3.2. Single Contributing Factor: Due to Intention to Offend

Upon this aspect, there are always the people who intend to offend and road traffic accidents are occurred due to these people. In this aspect, such people are kept away from traffic and their behavior is reformed by training and enforcement. In one hand, road traffic accident occurrence is always expected; on the other hand the identification of all offensive drivers is impossible. The experience shows that all of the efforts to identify these drivers are fruitless.

3.3. Single Contributing Factor: Due to an Accidental Phenomenon

Upon this aspect, traffic accidents are absolutely accidental and unpredictable which are due to destiny. Hence the risk of traffic accidents in different conditions is the same and traffic management section is unconcerned in system improvement and implements defensive remedies. So the reduction of the accident consequences is one of the most important measures for reduction accident costs.

3.4. Multi Contributing Factor: Due to Multi Accidental Phenomena

Upon this aspect, although road traffic accident is considered an accidental event, but it is the result of a set of events. Accidental events or destiny are irreversible. So an accident is absolutely accidental and unpredictable. Hence in this aspect is emphasized to reduce the accident consequences and the most probable contributing factor is identified and obviated.

3.5. Multi Contributing Factor: Static System

In this aspect, road traffic accident changes from an accidental event to a causative event. Accident occurrence is because of a set of static factors which are predictable and preventable and achieved by collecting and analyzing data after the accident occurrence. So the most important measure for reducing the number and severity of accidents is collecting and analyzing data on accident location, accident condition, and background data of initial phase of accident and identifying the most effective contributing factor. However the aspect is improved but the dynamic property of transportation and accident chain process are neglected.

3.6. Multi Contributing Factor: Dynamic System

The change in aspect of traffic accident from static causative system to dynamic causative system is achieved by the progress in human behavior studies and its interaction with environmental and traffic conditions. Upon the dynamic system, road traffic accident occurrence is because of a set of uncertain factors which are achieved by collecting and analyzing data after the accident occurrence.

Determination of all critical situations which are conducted to road traffic accident is essential for accident investigation and data analysis. This measure is the most comprehensive approach in this subject.

4. THE SHARE OF CONTRIBUTING FACTORS OF ROAD TRAFFIC ACCIDENTS

Road traffic accidents are happened in traffic system related to human, vehicle and road factors. The identification of the relation between these factors and their share are essential for prevention of accidents.

Based on the previous studies since 1970's in determining the share of contributing factor, two aspects are introduced: 1- traditional single factor aspect, 2- multi factor aspect. The results of the studies are presented as following.

4.1. Determination of Accident Contributing Factor upon the Single Factor Aspect

Generally, in developing countries the single factor aspect is used because of the lack of proper data, the lack of authority motivation, the lack of knowledge and etc. In this aspect, the cause of most accidents is human errors and determination of the contributing factor is done by police officers. The problem of this aspect is the lack of necessary motivation for vehicle and road safety improvement and generally this problem is due to the lack of proper public education. In table 2 the results of some studies in different countries are presented [4,5,6,7].

Table 2- The results of studies on the share of road traffic accidents contributing factors according to single factor aspect

Share of contributing factors in road traffic accidents(percent)			References
Human	Vehicle	Road and Environment	
65	30	5	Ministry of Housing and Infrastructure- Indonesia (1998)
75.4	10.2	14.5	University of Stellenbosch- South Africa(2003)
70-80	10-15	5-10	Ministry of Transportation South Africa(2004)
78	12	10	Institute of Road Traffic Education(IRTE)- India (2007)
52	18	30	Traffic Police- Iran (2009)

4.2. Determination of Accident Contributing Factor upon the Multi Factor Aspect

Since the early 1990's, regarding some developed countries applied the systematic approach for sustainable accident reduction, the results of studies upon the multi factor aspect were accessible and gradually this approach was completed. Determination of contributing factors share was done by emphasizing on the road and vehicle factor while the human errors were affirmed. These results conducted extensive evolution in the quality of transportation infrastructure. In table 3, the results of studies done by some research institutes and international organizations such as PIARC are presented.

5. ESTIMATION THE SHARE OF CONTRIBUTING FACTORS IN IRAN'S ROAD TRAFFIC ACCIDENTS

For estimation the share of contributing factors in road traffic accident, by analyzing available crash data, it was tried to use scientific and attributable method. For making decision, the different methods are prioritized and the best method is chosen. Among different methods which are considered, the Multi-Criteria Decision Making (MCDM) is a proper method and Analytic Hierarchy Process (AHP) has been used mostly in management affairs.

Table 3- The share of contribution factors in road traffic accident (%)

Factor \ Study	Human factor only	Vehicle only	Road only	Human Factor+ Vehicle	Human Factor+ Road	Vehicle +Road	Human Factor+ Vehicle + Road	Unknown Factor
TRL-1974	69.6	1.2	2.1	5.5	19.6	0	1.2	0.8
TRL-1995	65	2.5	2.5	4.5	24	0	0.3	1.2
PIARC-2002	57	2	3	6	26	1	4	1
Finland-2010	11	0	0	16	12	0	59	2

AHP analytical process is one of the most famous MCDM method that was innovated by Thomas L. Saaty in 1970 for the first time. AHP analysis process reflects the human thought and natural behavior. This method considers complex issues based on their interactions, converts them into a simple form then solves them.

When decision making process encounters multiple options and criteria, AHP analysis process can be implemented. Criteria may be quantitative or qualitative. This method is based on paired comparison. Decision maker starts with the preparation of hierarchy decision tree. Hierarchy decision tree shows the compared factors and competing options. Then a set of paired comparison is done. This comparison determines the weight of each factor in decision.

Finally, the AHP logic integrates the paired comparison matrix in a way that the optimum decision will be achieved. Three principles as the basis of AHP method are as following:

- Adverse condition: if the preference of A on B is n, the preference of B on A is 1/n.
- Homogeneity principle: element A and B should be comparable.
- Dependency: each element may have linear dependency to another up to the highest level.

The methodology was based on surveying from experts in road safety by the questionnaires. For this reason, the three main accident contributing factors based on Haddon matrix were considered and the questionnaires were designed with consideration of the main contributing factor, the interaction between the effective factors in accident and the share of factors and their interaction.

In this research, according to the experts' viewpoints, this fact was considered as default; human as the main accident contributing factor reacts incorrectly due to human errors because of physical or mental conditions or misunderstanding of external conditions and improper interaction with the other factors including traffic, road condition and vehicle.

The experts were selected from stakeholders and related organizations such as Police, Ministry of Road and Urban Development, Ministry of health, consultant engineers, Finally, after scoring the effectiveness of each contributing factor in road traffic accident based on AHP method, the relation and interaction between factors showing their share were estimated. The results are presented in table 4.

Table 4-The estimated share of factors in road accident in Iran based on dynamic multiple factors aspect

Factors	Human Factor only	Vehicle only	Road only	Human Factor + Vehicle	Human Factor + Road	Vehicle + Road	Human Factor + Vehicle + Road
Share (%)	35	3	4	11	17	3	27

Furthermore, this research was done based on the data of sever inter- urban accidents which resulted sever damage, injuries and fatalities and isn't comprised of damage accident occurred in urban area.

The results imply that the human factor is the main cause of road traffic accident. Human errors have a significant role in more than 90% traffic accidents occurrence. But the point in preventing and reduction the severity of accident is the estimation of contributing role of

vehicle (44%) and road and its environment(51%) and try to improvement the road and vehicle safety. Therefore reduction the human errors can be achieved by road and vehicle safety improvement.

6. CONCLUSION

The results of this research show that traditional single factor aspect should be replaced by dynamic multiple aspect in accident analysis to improve road traffic safety. Although, human factor is the main cause of road traffic accident, but the contributing roles of road and vehicle factor should not be neglected. Dynamic multiple factors approach can lead to effective road safety improvement by transportation infrastructure safety improvement and vehicle safety.

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