Evaluation of the behaviors of the Iranian drivers in respecting to the safe distance (Case study: Sari-Ghaemshahr road; Iran)

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Abstract
The road accidents are one of the main causes of death in Iran that effect on society, economy and loss of energy and resources. Identifying and removing effective factors in road accidents are less expensive than the cost of accidents. Many factors are involved in a road accident that can be classified into three general factors: human, road (with its around environment) and vehicle. The human factor is the most important factor because of variable behaviour and several mistakes of the human. One of the usual reasons of the accidents that relates to the human factor, is the distance between two vehicles or "time headway". The term "safe distance" in transportation is a particular distance between two vehicles in which the back vehicle can stop without any accident or crash when the front vehicle stops. In this study, the Sari-Ghaemshahr road was studied as the case study by videography. The results showed that 59% of the drivers usually do not respect to the time headway.

Keywords – safety, accident, driver behavior, safe distance.

I. INTRODUCTION

Road accidents, even in developed industrial countries are important factors in deaths and serious injuries to life and financial. The costs of accidents are so high and significant Therefore in the last few decades, many developing countries, like developed countries, carefully evaluate these costs and the results use in the technical and economic decision of officials and planners. Thus, the pre-emptive action is necessary to reduce accidents. The identification and investigation of effective parameters in the accidents and operating corrective performances to eliminate them can reduce the costs and improve the safety of the transportation system [1]. One of the most important factors which cause accidents is in non-compliance with the safe distance between cars. This is a human factor that can be overcome with education and law enforcement [2]. Khaki et al. in 2009 [3] investigated the cause of the accident, according to the classification of accidents (front to front - Front to back). In this method, the significant reasons and scenarios will be found after classification and the problem will be solved by necessary actions. One of the eventful roads of Iran was selected as a case study. After classification of accidents (front to front, front to back, side to side, etc.), it was clearly shown that the most accidents have occurred in the classes of front of the front (20%) and front-to-back (37%). The significant percentages of the classes of accidents were investigated by practical evaluation model of geometric design simulating traffic flow in IHSDM software. By using the software models, evaluating different scenarios and the parameters of geometric design and road traffic, the reasons of most accidents were completely known. The results of this study showed that evaluating the effective parameters on accidents is possible before occurring and important suggestions can be expressed to reduce the percentage of the accidents. In all scenarios, the weakness of geometric design is one of the accident parameters but the role of humans in increasing or decreasing of the accidents is evident. In fact, the high distance between the increasing and decreasing in accidents due to the human factor is the main reason of high accident rate in Iran.

Kazemi et al. in 2010 [4] studied the personal characteristics of the drivers in the accidents in Iran. They stated that the human factor is the most important factor among the effective parameters on accidents. Both physical and mental characteristics of the drivers were examined in their study. The physical and mental characteristics were divided into smaller classes such as sex, age, physical and mental problems and illnesses, the amount of alcohol consumption, etc. It is very helpful in understanding the different behaviors of the drivers and suggesting the appropriate solution for decreasing the accidents, fatality and monetary damages.

Ziyari et al. in 2011 [5] investigated the role of human factors in the road accidents, in their case study: Semnan Province, Iran. They focused on the main highway of this province; Tehran-Mashhad. Because this highway is important commercially, industrially, culturally and tourism. The human factor (contain: the driver's desires, judgment along the driving, the mistakes of the drivers, the errors due to the function, sensory and perceptual errors, lack of skill and speed) was investigated in this study as an effective factor in accidents. This study introduced the human factor as the main factor of accident in Iran.

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II. MATERIALS AND METHODS

1. Safe Distance and its Related Accidents

The position of two vehicles behind each other usually occurs in the roads. This position can be a dangerous condition for the occurrence of accidents, especially when there is not enough distance between the vehicles or the behavior of the front car driver has unpredictable behavior and the subsequently brakes. Generally, the drivers decide about the amount of distance between the vehicles. Therefore, the behavior of the drivers is important and should be investigated in the studies about the time headway and front to back accidents (because of low distance between vehicles). The investigation of the behaviors of the drivers is difficult because many parameters can influence on them. The factors affecting the drivers in choosing the distance from the front vehicle include sex, age, personal characteristics, education level and social status of the driver, the culture of the society, etc. [6]. Therefore, the main objective of this study is to understand these two questions: Why do not the drivers increase the distance of their vehicle from the front vehicle, even when they know that the distance reduction will increase the danger of the accident? Which parameters are effective in the choosing the distance between vehicles by drivers? Generally, in addition to the items listed before, selecting the distance from the front vehicle by the drivers depends on two factors:

1. The environmental factors. Such as the type of the front vehicle, the road characteristics, the road type, weather condition, etc.
2. The factors which reduce the attention of drivers. These factors include the actions that decrease the attention of the drivers about the road, events, decisions and actions of other drivers. It should be noted that they do not contain the situations which consumption of alcohol, drugs, narcotics, etc. will cause. These factors will increase the reaction time of the drivers and each one can have a level of complexity [7]. In the recent years, the experts pay attention to these secondary activities, because they are developing every day. In the early history of driving, the activities of the drivers along driving were limited but todays, due to the developing of modern devices and systems equipped with internet, mobile phones, etc., the number of activities that the drivers can perform while driving have enhanced. Therefore, the probability of the concentration in drivers has decreased [8]. In this study, the behavior of the drivers in choosing the appropriate distance from the front vehicle will be investigated and the effective factors and secondary activities on this choice of time headway will be evaluated. Also, their influences on the accident occurrence will study.

2. Time Headway

The term "time headway" is an interval in which two vehicles (that one of them is moving after the other immediately) pass from a certain point of the path. It usually calculates from the back bumper of front vehicle till the front bumper of the back vehicle. It is directly related to the distance which the driver of the back vehicle chooses (Fig. 1) [9].

In this study, the behavior of drivers in choosing or rejecting of the safety distance was evaluated via filed investigations. In this regard, the method of videography was used for one of the most important roads of Mazandaran Province in Iran; Sari-Ghaemshahr road. The visual assessment, length and time indices were the investigated parameters. The length and time indices in videos were maintained by natural signs (dimensions and markings on the pavement marking line) and the investigation of videos by frame to frame method, respectively. Also, the number of accidents that were occurred in this road because of as non-compliance is the longitudinal distance was taken from police office in Sari City.

III. RESULTS AND DISCUSSION

The high number of accidents in Sari-Ghaemshahr road was recorded by police; about 209 in 2012. The reason was known in the mistakes and weakness in these three factors: human, road (with its around environment) and vehicle. In fact, there is no accident when these three factors have perfect performance. Human is the most intelligent factor that can also control the other two factors. Therefore, human is always responsible in the accidents even when the other two factors have been caused the accident.

The media and the managers have stated the importance of the human factor that causes 70% of the accidents. The kind of vehicles crash is one of the methods of detecting the reason of accidents. For example, a lot of front to back accidents usually occur because of high speed and non-appropriate length distance with the front vehicle. The police office reported 11 factors related to human that cause accidents in the Sari-Ghaemshahr road. The lack of attention to the front vehicles was the main reason (92%) in the accidents. Next factors were the violation of speed (52%) and sudden change direction.
The reasons of the accidents in Sari-Ghaemshahr road reported by police have been shown in Fig. 2.

Fig. 2. The reasons of the accidents in Sari-Ghaemshahr road reported by police.

A: Lack of attention to the front vehicles, B: The violation of speed, C: sudden change direction, D: non-appropriate length distance, E: Not respecting to the priority, F: non-appropriate Transverse distance, G: Lack of ability in controlling the vehicle because of tiredness and drowsiness, H: Driving with reverse gear, I: overtaking from the right, J: passing in the width of the road, K: Non-ability in the control of the vehicle in encountering with a fixed object

The statistical analysis showed that the drivers (human factor) and theirs mistakes are the most important reasons in the accidents. Among the accidents occurred in 2012 in Sari-Ghaemshahr road, the reason of the in accidents in 180 cases was the humans and their mistakes. Also, many accidents have happened in front to back position. The percentages of different positions in the accidents have been shown in Fig. 3.

Fig. 3. The kind of crashes in the accidents accidents in Sari-Ghaemshahr road reported by police.

A: from to back, B: side to side, C: front to side, D: exiting from road, E: fixed object, F: wayfarer, G: overset

1. Evaluation of the behavior of the drivers about keeping the safe distance

This study was performed at 12 km after Sari City into Ghaemshahr City, where the most appropriate condition is geometrically provided for videography and there is no obstacle in that straight road. According to the reports, many accidents were occurred on Monday and between 1-2 PM in 2012. Therefore, this time was selected as the critical time for filming and investigation. The term "safe distance" is the duration of time required for the reaction of the drivers and braking when there is an obstacle. According to Iranian regulations of the roads, the reaction time is 2.5 seconds in Iran. Therefore, the critical time that is related to the safe distance, was considered 2.5 s.

About 59% of the drivers do not respect to the time headway (Table 1). The other analysis method used in this study that examined the risk of not respecting to the time headway.

The risk analysis of driver behavior means that which time headway and length distance the drivers usually select from the front vehicle. In this method, the time headway was divided into intervals of half a second, and the behavior of the drivers classified in different levels of the risk (Table 2).

Table 1. The number and the percentage of vehicles exceeding the critical time headway of 2.5 s

<table>
<thead>
<tr>
<th>The first lane</th>
<th>The second lane</th>
<th>The whole road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Vehicles %</td>
<td>Number of Vehicles %</td>
<td>Number of Vehicles %</td>
</tr>
<tr>
<td>Not respecting to the time headway</td>
<td>845</td>
<td>59</td>
</tr>
<tr>
<td>respecting to the time headway</td>
<td>576</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>1421</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2. Classification of the driver's behavior in different levels of the risk in Sari-Ghaemshahr road in the first lane

<table>
<thead>
<tr>
<th>Level</th>
<th>Duration (s)</th>
<th>Level of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0-0.5</td>
<td>Very high risk</td>
</tr>
<tr>
<td>2</td>
<td>0.5-1</td>
<td>High risk</td>
</tr>
<tr>
<td>3</td>
<td>1-1.5</td>
<td>Dangerous</td>
</tr>
<tr>
<td>4</td>
<td>1.5-2</td>
<td>Moderate risk</td>
</tr>
<tr>
<td>5</td>
<td>2-2.5</td>
<td>Low risk</td>
</tr>
</tbody>
</table>

The risk analysis of driver behavior for each lane and the whole of Sari-Ghaemshahr road was perfomed (Table 3; Figs. 4, 5, 6).
Table 3. The number of vehicles in different levels of the risk in Sari-Ghaemshahr road

<table>
<thead>
<tr>
<th>level</th>
<th>The first lane</th>
<th>The second lane</th>
<th>The whole road</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>59</td>
<td>40</td>
<td>99</td>
</tr>
<tr>
<td>2</td>
<td>239</td>
<td>195</td>
<td>434</td>
</tr>
<tr>
<td>3</td>
<td>155</td>
<td>221</td>
<td>376</td>
</tr>
<tr>
<td>4</td>
<td>155</td>
<td>211</td>
<td>366</td>
</tr>
<tr>
<td>5</td>
<td>118</td>
<td>182</td>
<td>300</td>
</tr>
<tr>
<td>Total</td>
<td>726</td>
<td>849</td>
<td>1575</td>
</tr>
</tbody>
</table>

Fig. 4. The percentage of the vehicles in different levels of the risk in the first lane of Sari-Ghaemshahr road

Fig. 5. The percentage of the vehicles in different levels of the risk in the second lane of Sari-Ghaemshahr road

Fig. 6. The percentage of the vehicles in different levels of the risk in the whole of Sari-Ghaemshahr road

V. CONCLUSION

The reasons of accidents in all cases can be summarized in these three factors: human, road (with its around environment) and vehicle. According to the police reports, the human factor is the most important parameter in the accidents. About 180 cases of accidents have been reported in 2012 in Sari-Ghaemshahr road, Iran. In the most cases, the mistakes of the drivers (human factor) were the main reason of accidents. Also, many accidents had been accrued because of lack of attention to the front vehicles and in the front to back position. It means that the appropriate distance from the front vehicle is not kept in this road. According to the report of police office, the reasons of accidents in the Sari-Ghaemshahr road contain lack of attention to the front vehicles, the violation of speed, tiredness and drowsiness of drivers, the deflection of the road.

After the investigation of regulations of the road in Iran and other countries such as Canada, Great Britain, France, Australia and AASHTO regulation, the time reaction for drivers was suggested 2.5 seconds. Also, this duration of time was selected as the time headway. In this study, the speed, length distance, time headway and safe distance were investigated by video data.

To analyze the behavior of drivers, the risk analysis method was used. In this method, the classification was performed according to the time headway of 2.5 s in 5 levels: very high risk, high risk, dangerous, moderate risk, low risk.

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