



Introducing a risk estimation index for drivers: A case of Iran



Abolfazl Mohammadzadeh Moghaddam^{*}, Esmaeel Ayati

Department of Civil Engineering, Ferdowsi University of Mashhad, Mashhad, Iran

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ABSTRACT

Objective: This paper intends to investigate the existing relationship between drivers' characteristics and their aberrant driving behavior (lapses, errors, and violations), accident and ticket rates. To achieve this, risky drivers groups are identified with introducing driver's risk index (DRI).

Methods: 1769 questionnaires were collected from Iranian drivers to gain information on drivers' personality, age, gender, education, driving behaviors (lapses, errors and violations), accident and ticket rates. Four indicators were used to describe the driver's characteristics so that the whole combinations of driver's characteristics and their relationship could be taken into consideration. K-means clustering and a non-parametric test were implemented to group the combinations within the homogeneous categories based on driving behavior, accident and ticket rates.

Results: The mean age of respondents was 36.53 (Standard Deviation (SD) = 11.33) with mean driving experience of 10.50 (SD = 9.63) years. The mean kilometers driven was 24875.89 km (SD = 24658.73) for 3 years. Results of the significance test (*p*-values) showed that there are no differences among lapses and errors with pairwise comparison across the whole clusters, however, other factors showed the most significant differences for resulting clusters by *k* = 4. Consequently, an ordinal 4-level risk index from 1 "safe" to 4 "risky" were identified. Also, a validation was performed by 158 questionnaires in order to confirm the results.

Conclusion: These ordinal levels can be used as a driver's risk index (DRI) to assess the effect of driver's characteristics on safety. The risk index would help to identify and target high risk drivers with safety Prevention programs.

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1. Introduction

Nowadays, the role of human factors in driving is increasingly drawing the meticulous attention of the researchers. Reduction of accidents and the resulted casualties, in particular, can be made with slight changes in driving behavior.

Iran has a noticeable rate of 36 casualties per one hundred thousand populations, (i.e., 27,000 per year) (Ayati, 2009). As the police have reported human failures as the main factor in more than 70% of accidents (PNC, 2011), this country requires crucial attempts to improve the driving behavior and culture. Through years, traffic researchers have been trying to identify the psychological factors that are thought to affect accidents (accident proneness, sensation seeking, thoroughness of decision making, etc.). Among such studies, investigating the association of five factors model (FFM) (Clarke and Robertson, 2005; Costa and McCrae, 1992; Lawton and Parker, 1998; Poropat, 2002), personality type-A (Boyce and Geller, 2002; Elander et al., 1993), attention deficit hyperactivity disorder (ADHD) (Barkley et al., 1996; Brandau

et al., 2011; Di Scala et al., 1998) with accident involvement and driving behavior can be mentioned. Furthermore, the role of demographic factors (age, gender, education, etc.) and the involvement of certain individuals in accidents have been investigated in several studies (Dobson et al., 1999; Granié and Papafava, 2011; Oltedal and Rundmo, 2006; Parker et al., 2000). In another study Kim et al. (1995) showed that driver behavior and either alcohol or drug use act as a mediated link between driver's age and sex and both accident type and injury severity.

Drivers' risky behavior may be compensated with their attention and skill and causes no crash for their own. However, it would make traffic turbulence and danger for other drivers. Hence, in order to identify the relevance between the driving style and accident risk, a number of self-report instruments such as driving behavior questionnaire (DBQ) (Reason et al., 1990), driving style questionnaire (DSQ) (French et al., 1993), and driving behavior inventory (DBI), (Glendon et al., 1993; Gulian et al., 1989), have been developed, all of which focus on self-reported behavior, drivers' decision making and driver stress respectively (Özkan and Lajunen, 2005).

Recent researches have addressed the driving behavior effect on accident involvement and its association with demographic factors

^{*} Corresponding author. Tel.: +98 5118910095.

E-mail addresses: ab_mo496@stu-mail.um.ac.ir (A. Mohammadzadeh Moghaddam), esmaeel@ayati.co.uk (E. Ayati).

(Boyce and Geller, 2002; Dobson et al., 1999; Nordfjærn et al., 2010; Oltedal and Rundmo, 2006; Steg and Brussel, 2009; Sullman et al., 2002). A closer look at these studies reveals that these studies mostly focus on a special aspect of behavior, personality and/or demographic factors and they further investigate the existing relationships and their extent in viewpoint of psychology. Albeit several studies have been aimed at identifying risky drivers among different ages and/or gender groups (Brandau et al., 2011; Deery and Fildes, 1999; Ulleberg, 2001), this field calls for further research.

The main objective of this research study is to present an index for classification of risky drivers/individuals with taking their basic characteristics into account based on driving behavior, at-fault accidents and traffic fines especially tickets. Identifying the risky drivers makes it more possible to assess individuals' potential for risk taking and facilitate driver safety analysis. Therefore, some countermeasures such as more instruction, surveillance and special planning could be adopted to reduce the risk potential.

2. Method

The following steps were taken in this research:

1. Drivers classification.
2. Data collection.
3. Analysis and results

The first section involves the indicators defining in order to systematically assess the main driver's characteristics which affect safety from driving behavior, at-fault accidents and ticket rates.

In the second section, the data collection procedure is explained. This information includes four sorts of data: personality traits, driving behavior, demographic characteristics, driving at-fault accident and ticket rates data which are collected by self-reporting.

The last section embraces the obtained data analysis as drivers grouping is made by means of personality traits and demographic characteristics and then the cluster analysis is implemented on these groups to provide categories containing the homogeneous effects regarding driving behaviors (lapses, errors, and violations), at-fault accident and ticket rates. Consequently, driver risk index (DRI) is defined based on the obtained clusters and finally this index is evaluated via a set of additional data.

3. Drivers classification

3.1. Personality trait

Personality traits have proved to affect driving behavior and accident involvement (Sumer et al., 2005; Ulleberg and Rundmo, 2003). In particular, persons who behave type-A personality pattern have a high level of competitiveness, an obsessive ability to work hard and fast subjected to time-limit pressures, work overload, and a willingness to cut pauses brief to complete the tasks (Evans et al., 1987). Type-As have a very strong sense of urgency and are able to get lots of work done even in the presence of distractions (Greenberg and Baron, 2003). Type-A people undergo irritability, frustration and anxiety because of their overemphasis on idealistic targets and perfectionism. They usually lose their tempers, bother co-workers and commit aggressive and sometimes forceful acts (Greenberg and Baron, 2003). In contrast, type B people are different from those of type-A. They are relaxed, considerate, patient, content and understanding. They show a high level of tolerance to the defects of others and bring into play problem solv-

ing approaches instead of overwork methods to manage stressful and difficult issues (Evans et al., 1987).

In terms of traffic safety, an evaluation of relationships between age, personality and driving style revealed that driver age and type-A personality characteristics were significant predictors of vehicle speed and gap acceptance. Evans et al. (1987) survey of the bus drivers in India and the United States revealed that Type-A bus drivers had more monthly accidents than those of type B. Their finding was supported by Suls and Sanders (1988) who argued that type-A drivers are more likely to involve in accidents and to die from crashes and violence. It was also found that risk taking behavior and accident involvement are positively associated with neuroticism, Type-A behavior, sensation-seeking, and high levels of extraversion (Frone, 1998; Hansen, 1989; Sutherland and Cooper, 1991).

Type-A individuals are usually more erratic and careless during the task performance (Shahidi et al., 1991). Moreover, type-A was associated with risk taking and accident involvement (Sutherland and Cooper (1991)), perhaps owing to the accompanying heightened sense of time urgency (Frone, 1998). Another research pointed out that aggression seems to be negatively related to traffic safety attitudes (Ulleberg and Rundmo, 2003). Also, the type-A behavior pattern was proved to be connected with increased accident risks (Magnavita et al., 1997). Tay et al. (2003) demonstrated that drivers with type-A behavior pattern have higher rates of traffic violations and crashes. They take more risks, drive more erratically, and are present in more incidences of aggressive driving and speeding.

Given the aforementioned review, it can be inferred that type-A drivers are more likely to be high in driving behavior and accidents than type-B drivers, therefore it was decided to measure personality factors to differentiate between individuals who are extremely self-assertive and aggressive (type-A personality) and those who are relaxed and patient (personality type-B). So, drivers were separated by binary indicator. Thereby:

PI = a: type-A driver
PI = b: type-B driver

3.2. Age

Previous studies have indicated that certain age groups are more likely to be over-involved in traffic accidents than other groups. However, there are few studies which have surveyed the relationship between traffic accidents and driver maneuver variable among various age groups. A recent study demonstrated that young and middle-aged drivers involved in accidents have larger probability of being in urban areas (Abdel-Aty et al., 1998). Matthews and Moran (1986) and Shope (2006) in their studies showed that young male drivers (26 years old and younger) are over presented in traffic accidents because they are overconfident and overestimate their driving skills.

Driving skills are affected by various variables, particularly age (Laapotti and Keskinen, 1998; Lee et al., 2003) and experience (Duncan et al., 1991). Age and years of driving experience appear to have a significant negative relationship with errors, highway and aggressive violations (Davey et al., 2007; Lajunen et al., 1998; Sullman et al., 2002). In addition, lapses would predict the accidents involvement among elderly and female drivers (Dobson et al., 1999; Parker et al., 2000).

Considering several previous studies, in order to find the relationships between age and other factors such as accident involvement and driving behavior, different age intervals have been chosen based on the available information or convenience. For instance, different groupings (<25, 26–35, 36–45, 46–55, >55), (15–19, 20–24, 25–64, 65–79, >80), (18–25, 26–30, 31–39, >39), and

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