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Exploring the risk factors associated with the size and severity of roadway crashes in Riyadh

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ABSTRACT

Introduction: Recently, growing concern has been shifting toward the necessity of improving traffic safety in the Kingdom of Saudi Arabia (KSA). KSA has a unique traffic safety problem in that: (a) it can be classified as a developed country in terms of the magnitude and quality of the roadway networks available and its compatibility with international standards; however, (b) it can also be considered a developing country as the rate of increase in the number of road crashes is substantial compared with relevant figures of other developing countries and other countries of the Gulf region. Hence, more research efforts are still needed. *Objectives:* This paper examines the nature and causes of fatal and serious traffic crashes in KSA so that solutions and/or future studies can be suggested. *Method:* Data from 11,545 reported fatal and injury traffic crashes that occurred in Riyadh (the capital of KSA) during the period 2004–2011 were analyzed by alternative and complementary methods. A logistic regression model was estimated and the results revealed that crash reason (speeding), damages in public property, day of the week, crash location (non-intersection location), and point of collision (head-on) were the significant variables affecting the binary target variable (fatal and non-fatal crashes). Additionally, the structural equation modeling approach was developed to identify and quantify the impacts of significant variables influencing crash size (e.g., no. of injuries, no. of vehicles involved in the crash). Crash size is one of the important indices that measure the level of safety of transportation facilities. *Results:* The results showed that road factor was the most significant factor affecting the size of the crash followed by the driver and environment factors. *Impact on Industry:* Considering the results of this study, practical suggestions on how to improve traffic safety in KSA are also presented and discussed.

1. Introduction

In the Kingdom of Saudi Arabia (KSA), traffic crashes are one of the greatest sources of external costs in terms of fatalities, injuries, property damage, congestion effects, and travel time. According to the Saudi official statistics (see Fig. 1), a total of 589,258 traffic crashes occurred in Saudi Arabia in 2012, an increase of approximately 8% compared with 2011. Moreover, the number of fatalities resulted from traffic crashes was 7,638, an increase of nearly 7% compared with 2011. Fig. 1 depicts the distributions of the total number of traffic crashes and fatalities per year from 2003 to 2012.

It can be noted from Fig. 1 that there are continuous increases in the number of traffic crashes and fatalities, with a rapid increase in the number of traffic crashes in KSA from 2006 to 2007 (about 53% increase), possibly due to the rapid growth in KSA construction that started in 2006.

To provide a rough picture of magnitude, KSA is composed of 13 administrative regions. The Riyadh region was first with respect to traffic safety problems, followed by Makkah and the Eastern Region. Approximately 26% of traffic crashes occurred in Riyadh between 2003 and 2012, followed by Makkah and the Eastern Region, with approximately 25% and 24%, respectively. These statistics are consistent with the distribution of the population (and most likely, the number of registered drivers) in Saudi Arabia.

The primary objective of this paper is to determine the significant variables affecting the severity (fatal or injury) of traffic collisions in Riyadh. In addition, it aims to identify and quantify the impact of the variables affecting the size of traffic crash in Riyadh (i.e., no. of injuries, no. of vehicles involved in the crash) so that remedies and/or future studies can be suggested.

2. Background

2.1. Prior studies that addressed traffic safety in Saudi Arabia

Few studies have been conducted to examine traffic safety problems in KSA. For instance, Koushki and Al-Ghadeer (1992) examined driver

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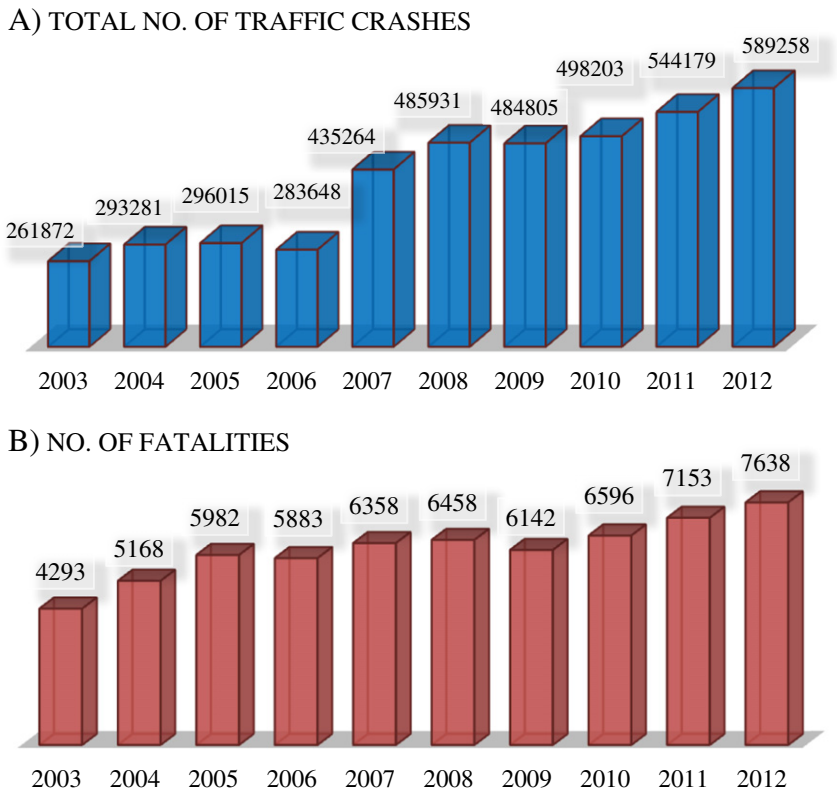

Fig. 1. Distributions of the numbers of total numbers of traffic crashes and numbers of fatalities in KSA between 2003 and 2012.

compliance with traffic regulations in Riyadh. The results indicated that drivers do not comply with traffic regulations everywhere (e.g., in urban or rural areas).

Al-Ghamdi (2002a) investigated the factors affecting pedestrian related crashes in Riyadh. Data reported by the police from 638 pedestrian related crashes during the period 1997–1999 were used. The findings showed that about 77% of pedestrians involved in these crashes were struck while crossing a road where no crosswalk existed. In addition, it was found that about 34% of the fatal injuries were located on the head and chest.

In addition, Al-Ghamdi (2002b) evaluated ambulance response time in Riyadh and compared it with the corresponding times in other countries. The results revealed that the mean response time was 10.2 min, which is below the acceptable standards in developed countries like the UK and the United States. Also, the time to serve one call takes, on average, 61.2 min with an 85th-percentile time of 66 min.

Moreover, Al-Ghamdi and Al-Gadhi (2004) assessed the effectiveness of using warning signs as countermeasures to camel–vehicle collisions in Saudi Arabia. The mean speed reduction of motorists passing these warning signs was the measure of effectiveness used in that study. The results indicated that after using such signs, the speed reduction ranged from 3 to 7 km/h.

Furthermore, Bendak (2005) used a survey to investigate drivers' behavior, personal characteristics, and their relationship with respect to using seat belts. The results showed that the rates of using a seat belt in two Riyadh suburbs for drivers were 33% and 87%, respectively. However, for the front-seat passengers, the rates of using a seat belt were only 4% and 41%.

Additionally, Al-Ghamdi (2007a) evaluated the effectiveness of fog detection and warning system on speed and headway under reduced visibility conditions resulting from heavy fog. The findings of this study revealed that the mean speed throughout the experimental sections was reduced by about 6.5 km/h. However, the warning system was ineffective in reducing speed variability.

2.2. Prior studies that addressed severity of traffic crashes worldwide

Many prior studies have examined the significant factors associated with the severity of traffic accidents in urban and rural areas, roundabouts, signalized and unsignalized intersections, work areas, multilane roads, and freeways.

For example, Gray, Quddus, and Evans (2008) performed an injury severity analysis of accidents involving young male drivers in Great Britain using ordered probit models. It was found that the characteristics predicted to lead to serious and fatal injuries include driving in darkness, between Friday and Sunday, on roads with a speed limit of 60 mph, on single carriageways, overtaking, skidding, hitting an object off the carriageway, and when passing the site of a previous accident.

Boufous and Williamson (2009) examined factors that contribute to the severity of work related crashes in New South Wales, Australia. The results indicated that age, gender, occupation, duty status, vehicle type, license status, fatigue, speeding, and location of the crash were the factors associated with the severity of the crash.

Daniels, Brijs, Nuyts, and Wets (2010) examined the severity of 1,491 crashes on 148 roundabouts in Flanders-Belgium using logistic regression and hierarchical binomial logistic regression techniques. The findings of this study pointed out that age, crash time (i.e., during night time), crash location (i.e., in rural areas), and type of crash (i.e., single-vehicle crash) affected the severity of crashes at roundabouts.

Das and Abdel-Aty (2010) examined the relationship of geometric and environmental factors associated with injury related crashes as well as with severe crashes using the Linear Genetic Programming (LGP) method. The results indicated that vision obstruction, percentage of trucks, road surface condition, median type, shoulders, and sidewalks widths were the main factors affecting accidents severity.

Haleem and Abdel-Aty (2010) examined the factors associated with traffic crash injury severity at unsignalized intersections in Florida using three approached: ordered probit model, binary probit model, and nested logit model. It was found that the traffic volume