ANALYTICAL COMPARISON STUDY OF TRAFFIC ACCIDENTS IN LIBYA

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الملخص

النمو السكاني السريع والزيادة في النشاطات الاقتصادية والاجتماعية أدى إلى الزيادة الهائلة في عدد المركبات والتي تعتبر من أهم العوامل الرئيسة المتسببة في حوادث الطرق في العديد من الدول النامية، من ضمنها ليبيا. خلال الفترة من 1995 إلى 2008 ازداد عدد المركبات المسجلة في ليبيا من 109,750 إلى 2,052,679 مركبة، أي بزيادة قدرها تسعة عشر ضعفا، بينما ارتفعت الزيادة السكانية إلى حوالي 24% في نفس الفترة [2].

يهدف هذا البحث إلى دراسة ومناقشة الحوادث المرورية خلال الأربعة عشر سنة الماضية، وذلك باستخدام نماذج عملية تستخدم في مجال السلامة المرورية تعرف بنماذج سمد، حيث تم تطبيق نموذج سمد بالنسبة لمعدل الوفيات (لكل مركبة)، ودراسة بيانات الحوادث المرورية ومدى مطابقتها لهذا النموذج، وتقييم مستويات التحسين في السلامة المرورية خلال فترة الدراسة.

حوادث المرور أصبحت من المشاكل الخطيرة التي تواجه ليبيا، حيث ازدادت حوادث الوفيات والإصابات بمختلف أنواعها بمقدار الضعف خلال فترة الدراسة. بينت هذه الدراسة أيضا أن معدل الوفيات والإصابات (لكل شخص) ازداد بنسبة 45%، وارتفع معدل الحوادث (لكل شخص) بنسبة 28%، بينما قل معدل الوفيات (لكل مركبة) بنسبة 90%، كذلك الحال بالنسبة لمعدل الإصابات والحوادث المرورية (لكل مركبة).

باستخدام نموذج سمد ومقارنة معدل الوفيات بالجماهيرية بنظيرها في الدول النامية والمتقدمة، أظهرت نتائج الدراسة أن ليبيا تقف على معدل مرتفع لعدد الوفيات (لكل مركبة) ومعدل مرتفع نسبيا كذلك في امتلاك المركبات. الوضع في ليبيا ينذر بأن هناك حاجة ضرورية وطارئة لتحسين مستويات السلامة المرورية، ولذلك يجب وضع الاستراتيجيات والبرامج للحد من الحوادث المرورية في هذه الدولة.

ABSTRACT

The rapid population growth and increasing in socio-economic activities have resulted in the enormous growth of motor vehicles which is considered one of the primary factors responsible for increasing road accidents in many of developing countries, including Libya.

During the period from 1995 to 2008, the number of registered vehicles in Libya has increased from 109,750 to 2,052,679, a nineteen-fold increase in fourteen years, the population has increased by 24% in the same period [2].

The main goal of this research is to study and discuss the traffic accidents in Libya over the last fourteen years, by using useful formula in traffic safety known as Smeed formula for death rates, and studying the validity of this formula in road accidents in Libya, and assessing the improvement levels in traffic safety through the period of study.

Traffic accidents have become a serious problem facing the country, the number of traffic accidents, injuries, and fatalities have increased nearly two times. This study showed that fatality and injury rates (per person) have increased by 45%, accident rates (per person) has increased by 28%, and the fatality rates (per vehicle) decreased by 90%, similarly for injury and accident rates.

By using Smeed model and comparing fatality rate for selected developed as well as developing countries results revealed that Libya stands at a higher position, with relatively high motorization level, this country has a higher fatality rate than both developed and developing countries.

The situation in Libya is alarming that the need for improvement in traffic safety is urgently needed; strategies and programs must be made to reduce the worsening situation of traffic safety in this country.

KEYWORDS: Traffic accident; Fatality rate; Injuries; Registered vehicles.

INTRODUCTION

The rapid population growth and increasing in socio-economic activities have caused an increase motor vehicles and consequently in traffic accidents, fatalities and injuries. Traffic accidents are serious traffic safety problems for developed as well as developing countries. 1.2 million People die each year on the world's roads and between 20 and 50 million suffer non-fatal injuries [1]. Libya as one of the developing countries suffers from serious accident problems.

Each year, more than 2000 fatalities and 6000 serious injuries occur in the country [2]. Libya is a developing country with its increasing population and growing economy. In parallel to this the number of registered vehicles is increasing rapidly, it has increased from 109,750 in 1995 to 2,052,679 in 2008, a nineteen-fold increase, the population has also increased by 24% [2].

During the period from 1995 to 2008, the number of traffic accidents, injuries, and fatalities have increased nearly two times (see Table (1) and Figure (1)).

Table 1: Population, registered vehicles and traffic accident statistics in Libya (1995-2008) [2]

Year	Population (million)	Registered Vehicles	Fatalities	Injuries	Total accident
1995	4.399	109,750	1296	7703	8419
1996	4.516	134,883	1080	7750	8437
1997	4.645	165,771	1119	8076	9278
1998	4.778	203,575	1224	8343	9393
1999	4.914	411,543	1204	8394	9370
2000	5.125	675,257	1504	8717	10667
2001	5.300	809,056	1598	10033	10895
2002	5.485	1,008,528	1751	11058	12017
2003	5.679	1,126,901	1744	10502	12154
2004	5.883	1,255,704	1785	10746	11643
2005	6.098	1,310,530	1800	11541	11898
2006	5.324	1,508,359	1866	12164	11982
2007	5.422	1,826,533	2138	13497	13165
2008	5.466	2,052,679	2332	13725	13352

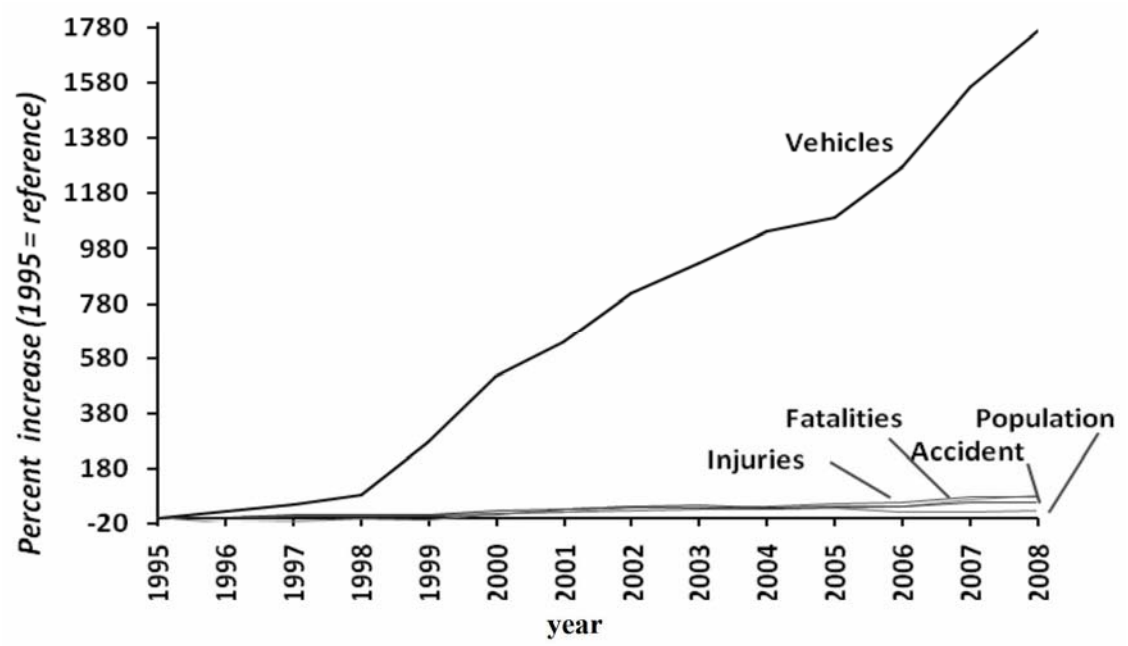

Figure 1: Trends in fatalities, injuries, accidents and registered vehicles

Figure (2) depicts that during the same period, fatality and injury rates (per person) increased by 45%, total accident rates (per person) has increased by 28%, and fatality rates (per vehicle) decreased by 90%, similarly for injury and accident rates. This figure also shows that there were tendencies for fatality, injury and accident rates per vehicle to decrease and per person to increase over time. Such trends agree with what Smeed found as will be discussed later.

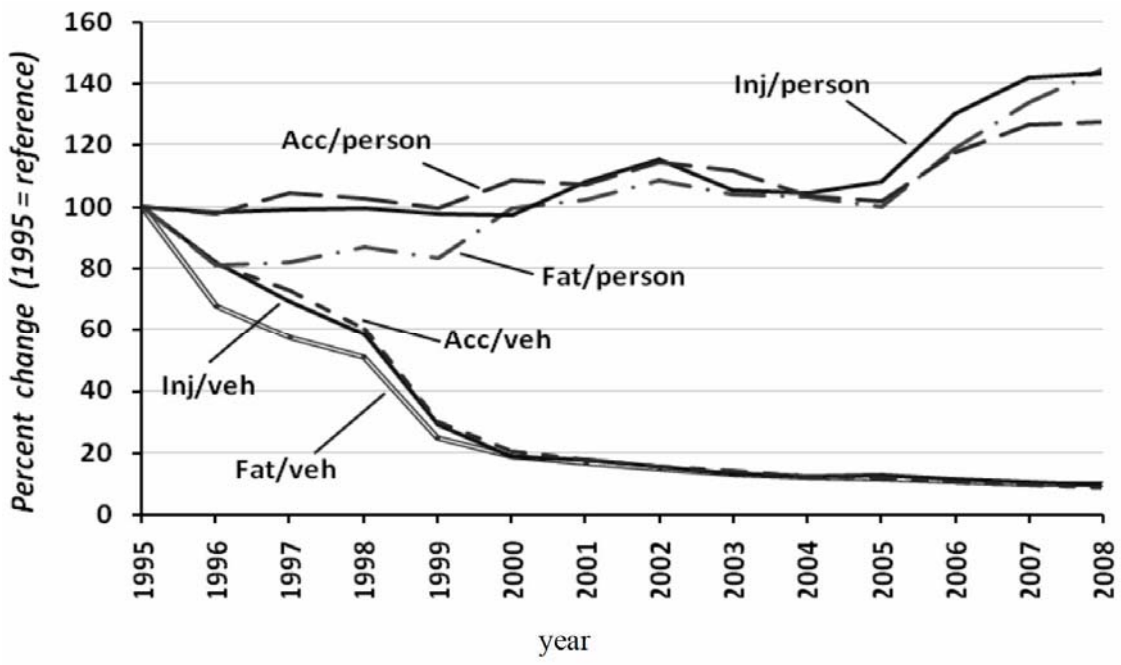

Figure 2: Trends in accident rates and risks per vehicle and per person in Libya (1995 - 2008)

The main objective of this research is to study and discuss the magnitude of road accidents in this developing country over the last fourteen years. This is has been done through analyzing the traffic accidents, fatalities and injuries by utilizing Smeed formulas to develop linear regression models. The fitted models subjected to statistical tests and compared with Libyan traffic accidents data to assess the improvement levels in traffic safety achieved in this country. In addition, comparison of traffic accident rates with those in some developing and developed countries were also considered.

DATA COLLECTION AND ORGANIZATION

Accident analysis process is a basic process for knowing causes of accidents and prevention, but this process is not completed unless the data is available and reliable about traffic accidents. In many developed world data may come from different sources including police, insurance, traffic agencies and hospital records. The situation, however, is different in developing countries, where the only sort of data is police, and the data is collected for purpose of litigation not collected with view of providing of research information [3].

The basic data for the analysis in this study were obtained from General Administration for Traffic in Tripoli, Libya, included fatal, injury, and total accidents in period of the study (1995-2008). In addition to registered vehicles were also revealed for the same period of time [2]. The population data is collected from General Authority for Information in Tripoli, Libya [4]. Table (1) depicts all of the above-mentioned data and information.

STUDY METHODOLOGY

In 1949 Smeed has developed a well known model indicating the death rate is inversely related to motorization level [5]. Smeed used registered vehicles as a measure of exposure to the risk of road accident, and successfully fitted Smeed's law to various time series and cross-sectional data. The safety model developed by Smeed can be expressed as:

$$\frac{F}{V} = \alpha \left(\frac{V}{P} \right)^{-\beta} \qquad (1)$$

where;

F = number of accident deaths.

V = number of registered vehicles.

P = number of population.

α *and* β = model's constants.

Smeed's law used to disclose improvement levels achieved on traffic safety through time, and also to compare improvement levels in developed and developing countries.

This model will be used for road accidents in Libya. The application of linear regression techniques will be considered, and then discussion will took place to know the validity and reliability of these models with road accidents in Libya.

TRAFFIC ACCIDENT MODEL DEVELOPMENT

Due to application of linear regression models on the collected Libyan traffic data during the study period, the following models for fatalities, injuries and total accidents, respectively, are obtained;

$$\frac{F}{V} = 0.00041 \left(\frac{V}{P}\right)^{-0.850} \quad (2)$$

$$\frac{I}{V} = 0.00243 \left(\frac{V}{P}\right)^{-0.891} \quad (3)$$

$$\frac{T}{V} = 0.00241 \left(\frac{V}{P}\right)^{-0.930} \quad (4)$$

MODELS' STATISTICAL RESULTS

The statistical results for the undertaken three models are summarized in Table (2).

Table 2: Model statistical regression analysis results

Formula LN(X/V)= ln(α) + β LN(V/P)	R^2%	S_e	$\frac{Se}{\overline{Y}}$ %	F-value	Model Significance at 5%
LN(F/V) = - 7.79 - 0.850 LN(V/P)	98.3	0.1080	-1.805	704.04	yes
LN(I/V) = - 6.02 - 0.891 LN(V/P)	98.8	0.0958	-2.321	980.94	yes
LN(T/V) = - 6.03 - 0.930 LN(V/P)	99.6	0.0584	-1.442	2871.38	yes

Based on the obtained results, the following facts were noticed:

- Confident intervals of the three models coefficients revealed that there is no chance to contain zero (α = 5%), so the intercepts as well as slopes are exist.
- The coefficient of determination *(100R^2)* explain very good proportion (for three models) of the total variation about the average of $\overline{Y}$ (over 98%).
- The standard error (S_e) of the three models gives small values, so these models can be utilized to predict their responses accurately.
- The standard error as a percentage of $\overline{Y}$ appeared to be small for all of the three models.
- The overall F-test for all of the three models are not statistically significant at risk level 5%, one can say there are relations between fatality, injury and total accident rate with motorization level.
- Residual plots show the fitted three models follow nearly normal distribution, and they illustrate that the models do not suffer from problems of regression models or non-constant variances.
- The results of the analysis provide sufficient evidence to support the hypothesis that the existence of strong relations between fatality rate, injury rate and total accident rate with motorization level.

MODELS' COMPARISONS AND DISCUSSIONS

The expected fitted values by utilizing Smeed's formula for fatality, injuries and total accident rates appeared to be in very good fit with actual observed values. The three developed models are plotted against the study period (1995-2008) with actual observed values and illustrated in Figures (3),(4) and (5).

Generally, these figures show downward trend for fatality, injury and total accidents rates, indicating that an overall improvement in safety levels achieved over years.

- It is obvious from Figure (3) that the fatality rates have deeply decreased from 1995 to 1999 (75% decrease since year 1995), however, the depression trend between 2000 to 2008 is small (49% decrease since 2000), which implying that there is no improvement occur in traffic safety levels since that year.

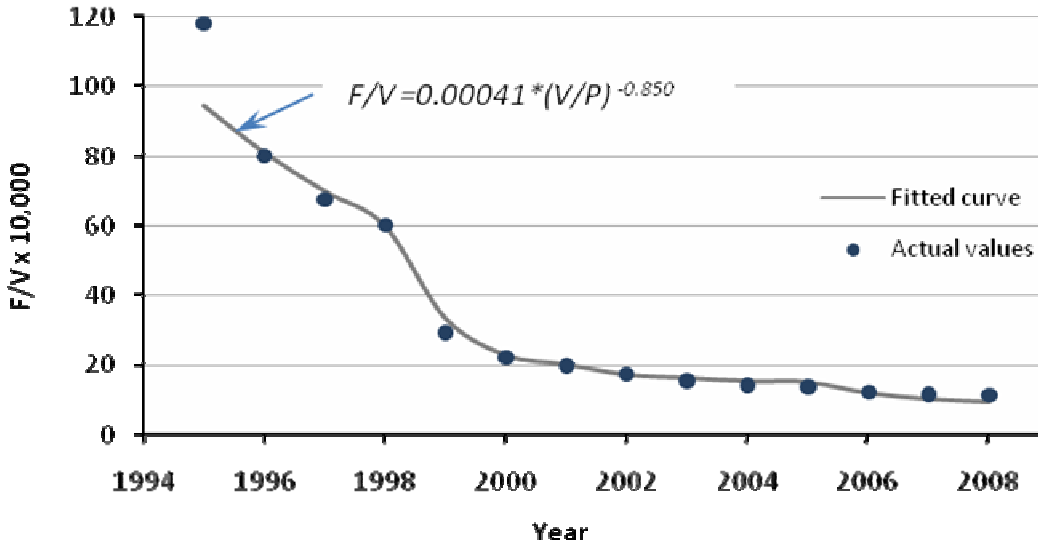

Figure 3: Actual and fitted values for fatality rates over years.

- From Figure (4), the injury rates from years 1995 to 1999 have depicted a deeply decreased (71% decrease since year 1995), however the depression trend between 2000 to 2008 is small (48% since year 2000), which implying that there is no improvement occur in traffic safety levels in this period.

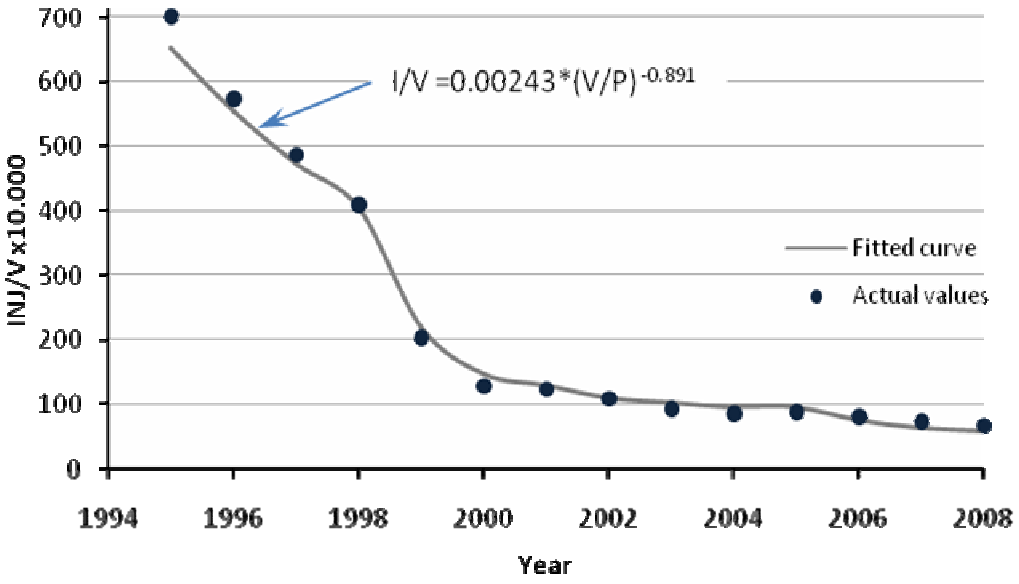

Figure 4: Actual and fitted values for injuries rates over years.

- Figure (5) depicts that there is a sharp decrease in total accident rates from 1995 to 2000 (70% decrease since year1995), which implying that an improvement in safety levels occur in this period, however the depression trend between 2000 to 2008 is small (51% decrease since year 2000), implying that there is no improvement occur in traffic safety levels in this period.

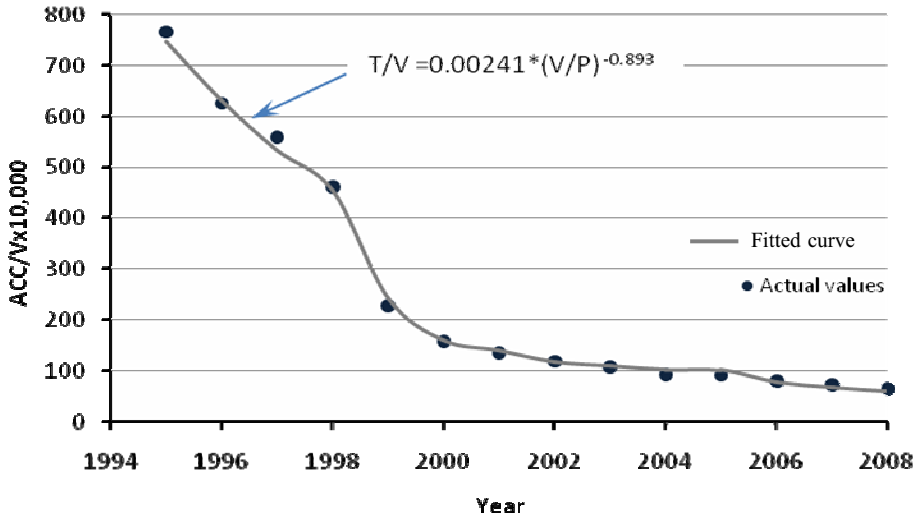

Figure 5: Actual and fitted values for accident rates over years.

When actual fatality rates plotted with fitted curves of developing and developed countries found by Jacobs and Cutting (1980-1986) and applying Smeed's formula which illustrated in Figure (6), the actual Libyan fatality rates against motorization level are found above both developed and developing countries curves.

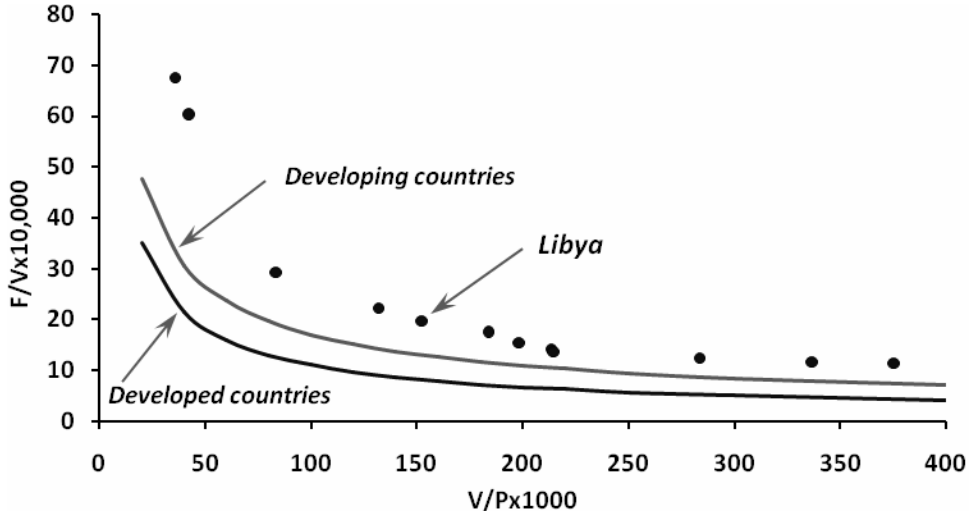

Figure 6: Smeed's fitted curves for Libya against developing and developed countries

When comparing fatality rates related to motorization levels for 35 selected countries (Figure 7), it can be noticed that Libya lies above the fitted curves for both developing and developed countries, which implies that Libya has very high fatality

rate, and Libya has higher motorization level than some other countries (e.g., Colombia, Morocco, Turkey, Brazil), some countries has high fatality rate as Libya (e.g., Egypt, Oman, South Africa).

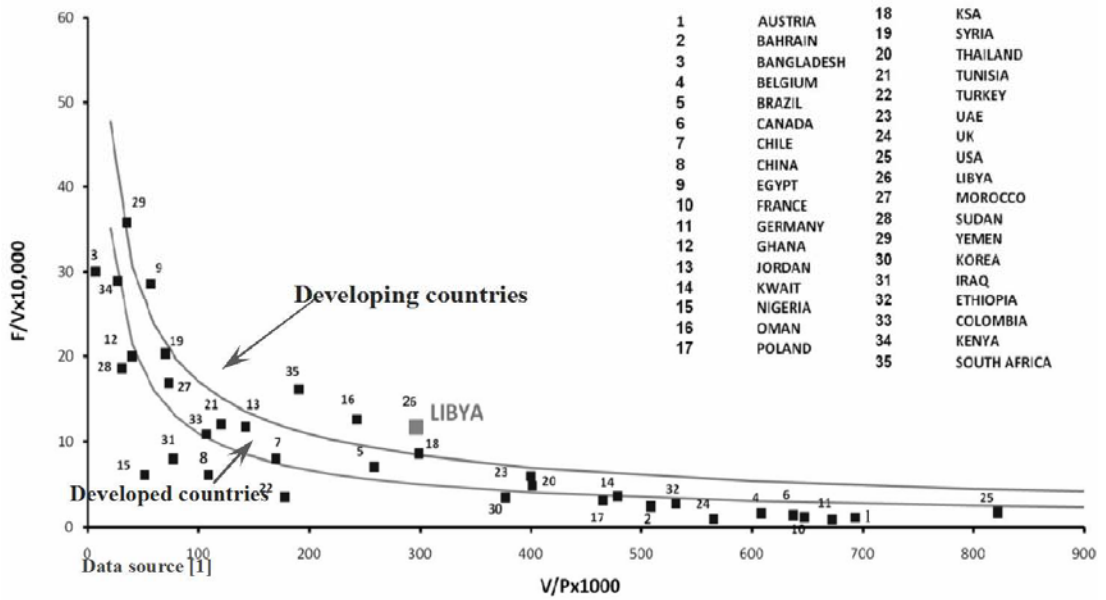

Figure 7: Libya and other countries with fitted curves for developing and developed countries.

When comparing road accident fatality rates (deaths per 100,000 persons) for selected developing and developing countries, it can be noticed that Libya has a higher fatality rate (per person) than for those countries. Among 35 countries, Libya ranks the first as depicted in Figure (8), about 43 deaths per 100,000 persons in traffic accidents in Libya.

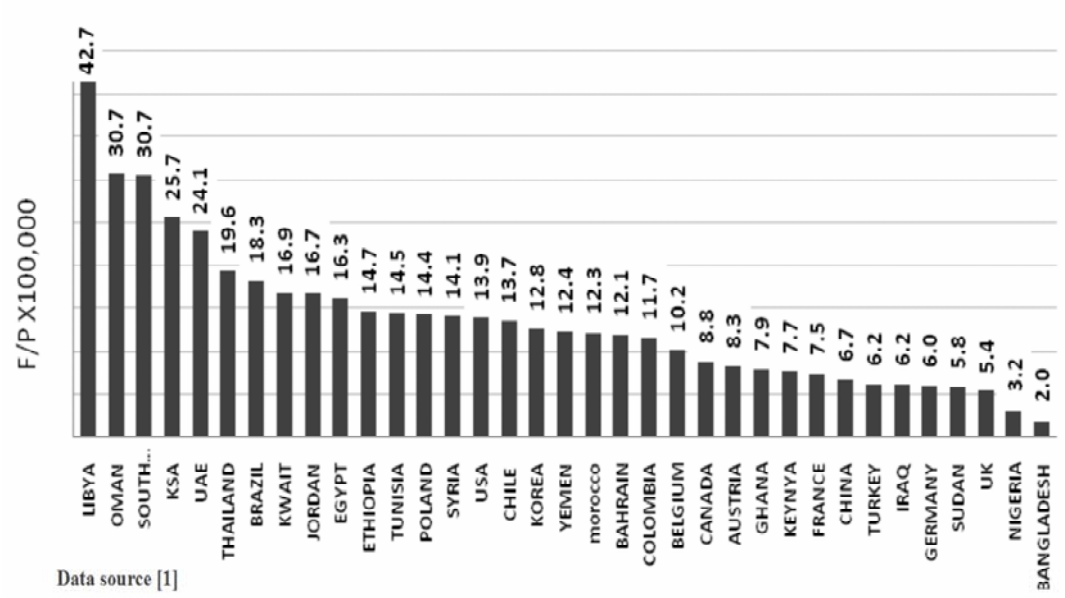

Figure 8: Death rates per person for various developing and developed countries.

CONCLUSION

The following conclusions are drawn based on the results of study:

- A general decrease in traffic accident rates per vehicle was found. However, a considerable increase in traffic accident rates per person was noticed, especially fatal and injury rates since year 2000.
- A general decrease in fatality, injury and total accident rates despite the considerable increase of motor vehicles, indicates that the traffic operation management in this country may have improved (could be worst).
- It is obvious that the three developed regression models using the Libyan traffic database (1995-2008) can be utilized to estimate the future fatal, injury and total accident rates.
- Despite the overall decreasing trend in traffic accident per vehicle, data have shown that this developing country has experienced a worsening situation in traffic safety levels since year 2000. That is fatality rate has increased from 29 per 100,000 persons in 2000 to 43 per 100,000 persons in 2008.
- Since Libya may be either classified as developing country or developed country, it has higher accident rates specially fatalities and serious injuries in comparing with developing countries, and it has more higher rates in comparing with developed countries.

RECOMMENDATIONS

Based on the above findings and conclusion the following recommendations are suggested;

- Trend data showed that the number of people killed on the roads in this developing country continuous to increase. Proper actions should be starting soon to prevent this hazard.
- Traffic accident reporting system is a problem in this country. Detailed engineering data and information should be available in order to carry out in-depth traffic accident analysis and researches. For example, driver behavior, road/vehicle factors, environmental impact, travel time, etc. Traffic data collection system should be improved and computerized.
- Deep traffic accidents study and researches should be started as soon as possible to investigate the current increasing trend in traffic accident rates, specifically fatality and serious injury rates.
- A traffic safety board to supervise the implementation of road safety programs and to evaluate traffic safety measures and strategies should be established. This board should also be responsible for directing research activities according to the problem needs.
- To deeply understand the nature and size of traffic accident problems, this country has to establish a traffic research center to conduct studies on contributing factors that causing traffic accidents.
- To reduce the number of traffic deaths, injuries and total accidents for this developing country, Libya has to participates in international road safety programs. The world road safety activities among participates agreed jointly to help and fund studies in order to assist the developing countries, knowing their road safety problems and finding alternative solutions.

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