

Road Safety in Jordan: Appraisal and Identification of Potential Interventions

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Abstract— Road traffic accidents are a considerable concern in both developed and developing countries because of their impact on social, economic and health issues. The level of traffic safety in Jordan, classified as a middle-income country, falls well behind many countries. The speed of economic development and population growth are expected to produce further increase in traffic volume and consequently an increase in traffic accidents. During the last 20 year, traffic accidents increased from 17838 accidents in 1990 to 144521 accidents in 2016. The magnitude of the problem, its rates of growth and the associated economical and social impacts are alarming calling the need for a detailed analysis of the present evolution of the problem, its causes, costs and possible effective countermeasures in an attempt to improve road safety. This study provides an overview of accidents trends and characteristics in Jordan. An attitudinal survey is carried out in order to identify the most effective and favorable potential countermeasures, as perceived by road users. The results of the study would help decision makers to take the necessary actions towards encompassing the problem.

Keywords— Road safety; Road traffic fatalities; Traffic safety interventions; Jordan.

I. INTRODUCTION

According to the World Health Organization (WHO) more than 1.2 million people die each year and more than 50 millions are injured as a result of Road Traffic Accidents (RTA). The majority of these accidents (over 90% of accidents and 80% of fatalities) occur in the low and middle- income developing countries[1]. The relationship between RTAs and number of motor vehicles was examined and the ratios of vehicles, population, and fatalities among the High income, Middle income and Low income countries are given in Table 1.

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TABLE I
THE RATIOS OF VEHICLES, POPULATION, AND FATALITIES AMONG
THE HIGH INCOME, MIDDLE INCOME AND LOW INCOME
COUNTRIES

	Low Income	Middle Income	High Income
Population	12	72	16
Registered Vehicles	1	52	47
Fatalities	12	80	8
Fatality Rate (/100,000population)	183	201	87

The figures in table 1 and research carried out in various parts of the world reveal that, compared with many western industrialized high income countries, accident rates in developing countries are high and that traffic safety is worsening in many of these countries. The problem continues to be a major socio economic problem for most developing countries due to rapid motorization and other factors with high cost [2,3]

A. Appraisal of Road Safety Situation in Jordan

Current traffic safety conditions are already extremely serious in Jordan and will undoubtedly worsen in the near future, in face of the rapid increase in the use of motorized means, within a travelling and social environments that are not prepared to experience such changes.

A number of studies investigated the magnitude of the problem, its rates of growth and the associated economical and social impacts [4,5,6,7] while other studies focused on the prediction of future number and severity of accidents [8,9,10,11]. A more recent study [12] carried the matter further producing a thorough investigation into the prediction, cost and strategy issues of the problem. In general, the results were alarming showing a low level of traffic safety in Jordan compared to develop and many developing countries and producing large socio-economic losses. The number of accidents has increased more than five-fold between 1995 and 2016 reaching 144521 accidents and 750 fatalities in 2016 with an estimated cost of JOD 323 (US\$500) million.[12,13]

i. Vehicle ownership and traffic composition

Two major factors that affect traffic accidents are population and number of vehicles. Both factors showed consistent increase in Jordan over the years. The population

has increased more than 71% between 2007 and 2016 from 5,723,000 to 9,798,000. During the same period the number of registered vehicles has increased by about 78% from 841,933 vehicles in 2007 to 1,502,420 vehicles in 2016. Many political events that took place in the Middle East region have significantly contributed to the population growth while the rising per capita income added to the reduced customs on imported cars and the inferior public transport service encourage private vehicle ownership.

The growth in population, the number of registered vehicles and the vehicle ownership (vehicles/population) over the 10-year period between 2007 and 2016 are given in table 2, vehicle ownership was about 2390 Veh /10,000 Person.

TABLE II
GROWTH IN POPULATION, NUMBER OF REGISTERED VEHICLES AND VEHICLE OWNERSHIP

Year	Population	No. of Registered Vehicles	Vehicle Ownership (Veh. / 10,000 persons)
2007	5723000	841933	1471.14
2008	5850000	905592	1548.02
2009	5980000	994753	1663.47
2010	6113000	1075453	1759.29
2011	6249000	1147258	1835.91
2012	6388000	1213882	1900.25
2013	8110000	1263754	2000.78
2014	8800000	1331563	2150.59
2015	9530000	1412817	2255.31
2016	9798000	1502420	2390.78

SOURCE: REFERENCE 13

ii. Accidents and casualty trends and rates

Jordan started to witness a modern development since the seventies which was reflected on the vehicle ownership and consequently on accidents and the resulting casualties during recent years. Annual statistics show that the number of accidents was 11,113 in 1979 with 354 killed. The figures have increased to 43,343 accidents and 612 killed in 1998. The corresponding figures in 2016 have increased to 144521 accidents, 750 fatalities.

Table 3 shows the number of total accidents, injuries, and fatalities in Jordan over the period 2007 -2016. It can be seen that accidents are increasing rapidly at a high rate while traffic injuries and fatalities are both increasing but at a lower rate than accidents. Fatalities have increased with time until they reached their maximum in 2007, and then declined.

TABLE III
CHANGES IN NUMBER OF ACCIDENTS, INJURIES, AND FATALITIES (2007-2016)

YEAR	Number Of Accidents	Number of Injuries	Number of Fatalities
2007	110630	17969	992
2008	101066	13913	740
2009	122793	15662	676
2010	140014	17403	670
2011	142588	18122	694
2012	112817	17143	816
2013	107864	15954	768
2014	102441	14790	688
2015	111057	16139	608
2016	144521	17435	750

SOURCE: REFERENCE 13

Three parameters, total number of fatalities, fatality rate per population and fatality rate per distance traveled, are considered particularly significant for comparative purposes and economics of projects. The other two parameter, fatality rate per vehicle and fatality index are commonly used to identify the seriousness of the road accident situation in one particular country. However, data availability controls the parameters to be used. For example, data on distances traveled are not available for most of developing countries.

Table 4 shows the changes in injury and fatality rates during the period (2007-2016). During the 10-year period, there has been an increase of almost 63 percent in vehicle ownership accompanied by 50 percent reduction in fatality rate (per 10,000 vehicles) as compared to the growth of population and almost the same fatality rate per 100,000 persons.

TABLE IV
TRENDS OF TRAFFIC ACCIDENTS RELATED STATISTICS DURING THE PERIOD (2007-2016)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fatalities/1000 accidents	8.9	7.3	5.5	4.8	4.9	7.2	7.1	6.7	5.5	5.2
Injuries/1000 accidents	162.4	137.7	127.5	124.3	127.1	151.9	147.9	144.4	145.3	120.6
Fatality Index *	0.052	0.05	0.041	0.037	0.037	0.045	0.048	0.047	0.038	0.043
Fatality/10,000 vehicles	11.8	8.2	6.8	6.2	6.0	6.7	6.08	5.17	4.3	4.99
Injury /10,000 vehicle	213.4	153.6	157.1	161.8	158.0	141.2	126.2	111.1	114.2	116
Fatality/100,000 populations	17.3	12.6	11.3	11.0	11.1	12.8	11.76	10.31	6.38	7.65
Injury /100,000 populations	314.0	237.8	261.9	284.7	290	268.4	244.3	221.6	169.3	0.13
Severity Rate **	0.17	0.14	0.13	0.13	0.13	0.162	0.16	0.15	0.15	0.13

*Fatality Index = No. of Fatalities/No. of Casualties

** Severity Index = No. of Casualties/No. of Accidents

iii. Contributing Factors

The major factors that contribute to the high rate of accidents may vary between countries. In Low-income developing countries, the factors include lack of safety belt and helmet use, a large number of old vehicles on roads that often carry more people than their capacity, poor road design

and maintenance and the traffic mix on roads[14]. In high-income rich oil countries human-related factors are the main contributors to high accident and fatality rates including reckless driving, and lack of observance to traffic regulations and traffic control devices. In Kuwait, for example, the level of observance of traffic signs by drivers was found to be very low where only 4% obeyed the Stop sign(stopped fully voluntarily) and over 70% violated the speed limit sign[2,15]

The limited resources of Jordan, classified by the World Bank as a middle-income developing country, may produce the following consequences:

- Many private and commercial vehicles are used beyond their normal life span, with attendant risk of sudden mechanical failure.
- The country is unable to build sufficient good quality roads or have adequate control devices that cope with the continuously growing demand.
- Streets have deteriorated and traffic chaos occurs with different kinds of traffic sharing the same street un-segregated especially in rural areas
 - Inadequate Street lighting which, if added to poorly lit vehicles, increases the risk of accidents at night.
 - Inadequate pedestrian's facilities, both in quality and quantity.
 - There are few refuge islands in the center of wide streets, few markings and very few traffic lights with "walk" sequence, so that pedestrians are usually at risk.
 - Moreover, road user behavior is reckless and drivers routinely ignore traffic laws and pedestrians routinely walk in the middle of streets cross without checking for traffic.

Studying the factors contributing to accident occurrence in Jordan showed that road users contributed to 94.74% of total reported accidents, whereas road failures and vehicle defects contributed to 4.46% and 0.80% respectively.

B. Identification of Potential Interventions

The road safety issue has long been the focus of attention in developed countries and their fatality rates are generally improving, while relatively little is done to reduce the magnitude of the problem in developing countries. High-income countries have successfully implemented effective interventions to help reduce the burden of road traffic accidents while low- and middle-income countries have not yet achieved similar results noting that both scientific research and capacity development have proven to be useful for preventing accidents in high-income countries[16].

i. Best Practice Strategy

Jordan suffers from a serious road safety problem that must get more attention from the decision makers. The magnitude of the problem, its rates of growth and the associated economical and social impacts are alarming which requires the researchers and decision makers to provide approaches to reduce the overall number and severity of accidents.

However, the implementation of road safety measures bears a lot on the various stakeholders with multitude of interests

leading to the development of what is termed "Best Practice" strategy for road safety [17]

Best Practice" refers to a road safety policy that has proven to be successful meaning brings about a sustainable reduction in the number of road accidents and in particular the number of resulting casualties.

Five pillars were identified as the focus of action to improve road safety. These are:

1. Road safety management;
2. Safer Infrastructure;
3. Safer vehicles;
4. Safer road user behaviour and
5. Improved post-crash care.

ii. Identification criteria of best practices

The best practice candidates are identified and described based on the following criteria [17]:

1. Focus of the measure: a clear definition of the road safety problem to be solved and precise idea of how the measure will affect this problem.
2. Magnitude of the road safety problem
3. Expected effects on safety which addresses the process of implementation.
4. Evaluation of effects on road safety based on accident statistics
5. Costs and benefits analysis
6. Acceptance by public and policy makers
7. Sustainability over time
8. Transferability: using the measure successfully on a larger scale (regional/national level).

iii. Methodology

The process to develop the best practice is carried out by reviewing different approaches that were developed in a various countries. The first phase of the study involved selection of a number of best practice measures that are considered relevant to improve future traffic safety in Jordan. As a starting point, a set of instruments was prepared.

- A list of road safety measures in order to select the best practice measures;
- A decision upon the selection criteria for the best practices which was the acceptance of drivers' population to these practices.
- A questionnaire for data collection in order to provide an insight into these issues with the aim of evaluating how effective road users thought the best practice measures would be in reducing the number of accidents (effectiveness index on a 0-5 scale), and also how much they would be in favor of the measure if actually being introduced (favourability index on a 0-5 scale).

In order to be labeled as Best Practice, a measure should comply with most of the selection criteria. In particular its effectiveness in terms of expected reduction of road accident, deaths and serious injuries should have been demonstrated in previous scientific work. The acceptance level of drivers' population to these practices is another important factor in the

selection process.

iv. The Attitudinal Survey

A predesigned questionnaire was prepared and distributed to collect information on what representative sample of road users with different income and educational level thought about a variety of possible best practice measures

In total, 39 Best Practice nominations were chosen, taking the above selection criteria into account. The measures were considered to reduce traffic accidents and were devised to gauge how well the public might accept and favor them as countermeasures (CMs), and how effective these measures were as perceived by road users. The public road users were asked to report their attitude towards these measures in terms of "effectiveness" and "favorability" of the CMs.

The effectiveness of the different CMs was obtained using a five point rating scale having a verbal label as follows: 1- Negative effectiveness 2- Not effective 3- Less effective 4- Highly effective 5- Very highly effective. Ratings of how much respondents were in favor of each CM were also obtained using a five point scale as follows: 1- Strongly against 2- Against 3- Neutral 4- Support 5- Strongly support

Analysis of the responses involved ranking of the countermeasures according to their perceived effectiveness and favorability using two indices namely "effectiveness index" and "favorability index". Each index represents the arithmetic mean of all the rating responses from 1 to 5 with the higher indices given lower ranking number.

The effectiveness and favorability indices were combined for each remedial measure, giving equal weight for each index, in order to rank the measures in terms of the merging between effectiveness and favorability. The results shown in table 9 which gives a listing of the highest and the lowest ten measures thereby enabling the identification of those interventions with the highest potential for improving road safety in Jordan.

TABLE V
THE HIGHEST AND LOWEST EFFECTIVE AND FAVOURABLE INTERVENTIONS

Remedial Measure	Effectiveness and Favorability Index	Rank
Control intensification on over speed violations in rural roads	4.085	1
Control intensification on over speed violations in rural roads	4.06	2
Decreasing the maximum speed limits over urban roads	4.015	3
Impose the use of reflecting triangle	4.01	4
Placing of dangerous crossing signs on high accidents places	3.975	5
Increase traffic education in schools	3.96	6
Using automatic jail penalty against drunk drivers causing accidents	3.955	7
Increase the number of play parks to decreasing stopping of cars on the roads	3.88	8
Removing the obstacles from medians that restricts sight distance like trees.	3.88	9
Provide safe sidewalks for pedestrians free of obstacles.	3.875	10

Increase the penalty value (ticket) for traffic violation	3.67	29
Decreasing max. speed limits during night by 10 Km/h	3.665	30
Impose using of safety belt in the back seats passengers	3.665	31
Decreasing max. speed limits along highways	3.625	32
More concentration of the driving test on written part	3.62	33
Retesting drivers who are over 65 year every five years	3.545	34
Reconsideration of the openings in the median islands for highways and main roads and closing the unjustified among it.	3.54	35
Increase legal age for obtaining driving license	3.53	36
Increase the difficulty level of the driving test	3.475	37
Retesting drivers every five years	3.385	38
Increasing max. speed limits along highways	3.02	39

v. Areas of action for sustainable road safety in Jordan

Road user factors were identified as the most contributors to traffic accidents in Jordan with reckless driving, and lack of observance to traffic regulations are among the main factors. The road network continues to expand in Jordan with improving design and maintenance standards but there is still potential for improving the road safety standards of these networks such as improved street lighting and installing guard rails. Jordan also has high technical standards for newly imported vehicles and for vehicles in use that ensures road worthiness of motor vehicles. However, the level of implementing these standards is not as high as the standards

and requires a lot of attention and revision.

Jordan does not have an official national road safety strategy but action plans. Three action plans were prepared 2008-2012, 2010-2013 and the most recent 2013-2017. However the first two plans were not fully implemented as planned. The third plan aims at the followings:

1. Reduce the number, rates and severity of traffic accidents and their social and economical impacts.
2. Provide safe and efficient traffic movement with reduced traffic congestion.
3. Improve the level of traffic and road safety education of the general public.
4. Improve the efficiency of the personnel working in the traffic sector.
5. Treatment of high accident locations as identified by the studies carried out annually.

In view of the above, some important work which provides future efforts towards improving road safety in Jordan, but not limited to, specific areas of action, are listed below. These actions are based on the application of the five Es (Education, Enforcement, Engineering, Encouragement, and Evaluation) and the two Cs (Coordination and Cooperation).

1. Developing and implementing national road safety strategy focusing on vulnerable road users; pedestrians and young drivers in particular.
2. Developing and updating of highway and traffic manuals, standards, materials and guideline. These include specific documents for design, work zones, Road Safety Audit, and road safety education.
3. Adopting a system for the evaluation of road safety performance
4. Continuous cooperation and coordination between the various stakeholders at all level ; national, regional and international
5. Allocation of sufficient funding and resources
6. Introducing a world –class emergency medical services system.

It should be noted, however, that measures that are very successful in achieving significant major benefits in certain countries may not be that successful in another country, due to the complexity of the inter-relationship that exists among the traffic variables and driver attitudes.

II. CONCLUSION

This work shed some light on the road safety situation in Jordan. The results of the investigation reveal that the magnitude of the problem is alarming and continues to be high compared to developed countries and that the country still suffers from sustainable increase in traffic crashes despite the humble attempts and efforts to reduce their magnitude and severity. However, a review of the progress in road safety initiatives developed or implemented indicate that there is still a considerable room for improvements.

The best practice approach is used and an attitudinal survey is carried out to identify the potential interventions based on

the effectiveness and favorability of the various measures as perceived by the road users. Some important work and specific areas of action which provide future efforts towards improving road safety in Jordan, are identified.

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