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Estimation of Socio-Economic Cost of Road Accidents in Saudi Arabia: Willingness-To-Pay Approach (WTP)

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Abstract

Road accident is one of the major causes of death in KSA. Therefore, making some important decisions, such as investing in traffic safety, improving roads or distributing research priorities and the necessary activities to strengthen the safety, all require either implicitly or explicitly the evaluation and estimation of the costs of these incidents, in order to make sure that those investments have an economical feasibility in the light of the limited economic resources. This research estimates the overall economic costs of road accident through focusing on estimating the value of human life and humanity, by measuring the probabilistic value of the willingness-to-pay, according to the model of Jones-Lee and others. This research also estimates the value of a statistical life (VOSL) for car drivers in Saudi Arabia, depending on applying the willingness-to pay approach, through a list questionnaire, depending on survey methodology. Results indicate that the Mean of the value of a statistical life in KSA was amounted to Saudian Riyals (SAR) 3.4 million. Accordingly, the cost of the life loss in KSA reached about SAR 49.4 billion, compared to the traffic accidents costs in general, including the fatalities, injuries and damages estimated to be SAR 54.9 billion.

JEL classification numbers: J17, D61, J28, Q51.
Keywords: Road Accident, Willingness-To-Pay, Value of Statistical Life, Saudi Arabia (KSA).

1 Introduction

The injuries caused by road accidents are considered as the highest important reason behind the death, disability and losses of properties in all parts of the world especially in low and middle income countries, till traffic accidents become one of the most important causes of human and economic losses in urban communities in today's world, especially with the simultaneous increasing in the rates of the transportation and movement from one

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place to another, by using different and various transportation means and tools, like cars, trucks, bicycles, motorcycles, trains, etc.; which facilitates the occurrence of accidents, leading to cause human life loss. The traffic accidents cause the occurrence of large and enormous human and economic losses in many times. These losses come out from the treatment costs, decrease/loss of productivity of the dead or those who become disabled because of their injuries.

One of the recent reports of the World Health Organization (WHO) in 2013 has indicated that globally, nearly 1.24 million people die each year as a result of traffic accidents. It is expected that these fatalities will rise to about 1.9 million people per year by 2020, if no measures are taken. The report indicates that more than 91% of these fatalities resulted globally from road accidents occur in low and middle income countries, despite the fact that these countries possess only less than half of the vehicles of the world. In contrast, there are approximately 20 to 50 million persons who are exposed to non fatal injuries as a result of these incidents, many of which lead to disability (WHO, 2013).

The UK Transport Research Laboratory Report, 2000 estimated the economic costs associated with traffic accidents to $518 billion annually, and that about $65 billion of these costs occurred in low and middle income countries (Jacobs, Aeron-Thomas, Astrop, 2000).

By focusing on the injury costs to the path of the Gross National Product (GNP), and based on the World Health Organization (WHO) report on road traffic injuries, the cost of these accidents is estimated at 1% of GNP in low-income countries, at about 1.5% in middle-income countries and at 2% in high-income countries (Peden, Scurfield, Sleet, and Hyder, 2004).

Global health programs have ignored injuries caused by traffic accidents for many years, in spite of the possibility, to a large extent, to predict and prevent them. Data derived from many countries show that great successes can be achieved in the prevention of traffic accidents, through exerting concerted efforts that include other sectors than the health sector.

With all these estimates, they still focus on measuring only the direct effects. Accordingly, these losses will become more, if we take into account what these incidents leave behind of social aspects. In addition, human losses resulting from traffic accidents are inversely related to the urban growth and the societal progress, especially because the most of the traffic accidents victims are young and productive elements in the society.

In KSA, the society suffers from the problem of high rates of road accidents, and the KSA has also become one of the top countries that suffer from this problem and what it leaves behind of human and economic losses. During the past years, the KSA has witnessed a remarkable rise in the proportion of the number of road accidents that were accompanied by an increase in the number of fatalities and injuries; thus has become one of the main important growing problems and issues facing Saudi Arabia's population, owing to what they leave behind of heavy social and humanitarian tragedies.

1.1 The Cost of Traffic Accidents

The Saudi society has suffered, like other Middle Eastern societies, as a result of aggravating the problem of traffic accidents, which resulted in its entirety to an increase in fatalities and injuries cases, especially in the main big cities. Statistics indicate the huge size of the problem and its impact on the national level, as the number of traffic accidents

in KSA in 2012 reached about 589.3 thousand accidents, and the number of their consequent fatalities about 7638 deaths, and leaving behind about 41.1 thousand infected. KSA is considered the third highest Arab country in recording the highest fatalities as a result of road accidents, as shown in Figure 1.

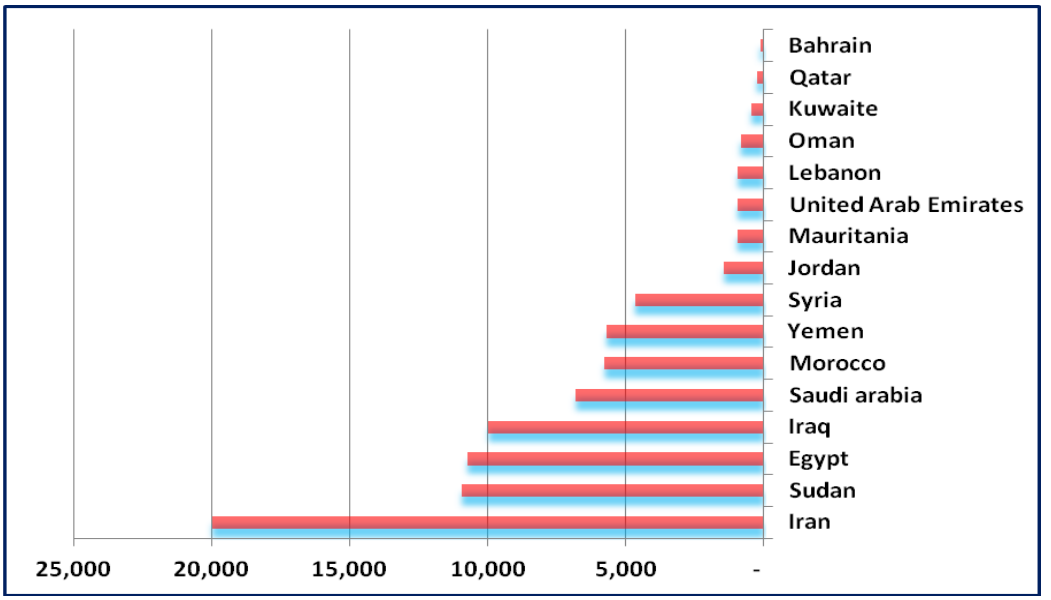

Figure 1. Road Accident fatalities in 2010

Source: Commander, Nikoloski and Vagliasindi's' elaboration based on Institute for Health Metrics and Evaluation's Global Burden of Disease (GBD) dataset, 2014.
World Health Organization (WHO) , Road traffic injuries, Fact sheet N°358, March, 2013. Global Status Report on Road Safety 2013: supporting a decade of action, Geneva, Switzerland, 2013.

But the issue do not stopped at these numbers, but goes beyond them in the future, predicting the inflation of the problem size. This is due to many and varied reasons. One of the most important reasons is the simultaneous increase in the number of registered and used vehicles in KSA, as they increased from 8.4 million vehicles in 1990 to 14.9 million vehicles in 2011; in addition to the increase of growth rates in the number of imported cars significantly from one year to another, as this number increased from 91.1 thousand cars in 1996, to 210.6 thousand cars in 2000, to reach 981.9 thousand cars in 2012, which leads us to expect the traffic problems exacerbation; and thus, traffic accident rates are expected to increase (Department of Statistics, 2012).
On the other hand, the number of traffic accidents has increased dramatically in the year 2012, whether inside those cities or outside them, and especially in the three major cities (Mecca, Al Sharqiyah and Riyadh), as the number of these accidents amounted to be about 589.3 thousand accidents, leaving behind them about 41.1 thousand casualties. Although it is agreed on this number in an official census of KSA, and although it is agreed on the total number of fatalities, there is a clear difference in estimating the number of fatalities caused by traffic accidents. Although the official estimates as an absolute census are about 7638 fatalities, the official statistics estimates at the same time

that the number of fatalities in road accidents is up to 49 fatalities per 100 Thousand of the population (Department of Statistics, 2006).
On the other hand, both of these official statistics still do not accurately reflect the size of the problem, because the road fatalities in KSA are defined as the death that occurs at the site of the incident or within 24 hours of the incident, unlike the global definition which is taken now in the majority of the developed states and some of the developing states of road accidents, which defines the death as every death occurs within 30 days of the accident. Thus, the estimates of the dead persons as a result of traffic accidents are expected to involve a great simplification as a result of not standing on the real total number of fatalities caused by real traffic accidents. In other words, if the global definition is used, the number of deaths of these accidents will significantly increase.
This research is supposed that the number of fatalities in road accidents is estimated to be 49 fatalities for each 100 thousand of populations. Accordingly, the number of fatalities at the present time (2013) is estimated as 14651 deaths, taking in consideration that the number of the population is up to 29.9 million persons.
These traffic accidents resulted in high economic costs, which are not only represented in the individuals' injuries and losses in the vehicles as assets, but their impacts generally exceed the material losses. Specifically, this research estimates the direct and indirect costs resulted of traffic accidents, with both their economic and social dimensions, whether on the individual or the community, in an effort to perceive the true image of the burdens incurred by the national economy as a result of these incidents.

1.2 Objective and Scope of Study

This research aims to make an initial estimation of the life value of Saudi cars' drivers, and the quest to use it in estimating the size of the annual economic and social losses incurred by the state as a result of traffic accidents.

2 Literature Survey

TRL (1995) had pointed out about six regular approaches and methods, that can be reliable on when estimating the traffic accidents costs, which are; The "gross output" (or human capital) approach, The "net output" approach, The "life-insurance" approach, The "court award" approach, The "implicit public sector valuation" approach, and The "value of risk change" or "willingness to pay" approach.
Moreover, Ghee, and et al. (1997) has estimated that half million serious accidents take place yearly in the world and that 70% of those accidents occur in the developing world. Also the total cost of traffic accidents has been estimated of about USD 230 billion per year, of which the estimated share of developing countries is about USD 36 billion, although 70% of fatalities in traffic accidents occur in these developing countries.
In addition, High Commission for the Development of Riyadh (2003) has estimated that such accidents cost those developing countries between 2% to 4% of GDP annually, taking into consideration that, the human losses as a consequence to traffic accidents are inversely proportional to the urban growth and the progress of the societies, especially because the vast majority of victims of traffic accidents are from the youth and productive category in society.

While De Leon, et. al. (2005) has sought to move beyond those studies that focused on estimating the economic impacts of traffic accidents, to focus on other social aspects resulting of these incidents; as the study sought to estimate the economic and social impacts of traffic accidents in Philippines, based on the use of human capital approach, which focuses on the total output of the traffic accidents victims. The costs have been specified in three main groups, which are the cost related to the victim, loss of property, and the administrative costs. The monetary value for each of these groups is estimated in this study according to the four recognized types of accidents, which are severe or fatal accidents, serious damages, light damages, and property losses only.

The study concluded that every fatal traffic accident, causes a loss of about 3.5 million PhP, which reflects the large amount of economic losses resulting of traffic accidents, as well as the social costs resulting of pain, grief and suffering caused by these incidents, estimated by 506,450 PhP for each fatal accident.

While (Ghee, and et. al., 1997) has estimated the economic and social impacts of traffic accidents in the developing countries by using The 'Gross Output' approach, as the best way to estimate the costs of traffic accidents. This approach is based on the aggregation of the output loss value, resulted of the victim in the accident, the medical costs, the loss of property, and other administrative and procedural costs incurred by the society. Ghee Study has included also other non-economic aspects, in order to include the social aspects such as Pain, Grief and Suffering that cause great moral damages to individuals and families as a result of the loss or the injury of their relatives in those incidents.

(Barnett and et al., 1999) has divided the traffic accidents effects into three main sections. The first section is represented in the real resources costs, which include the losses and the damages to vehicles, roads structures and objects, the alternative opportunity cost to equip ambulance and traffic police, judicial and procedural costs for adjudicating and judging in the accidents, and the costs of medical treatment and burial services if the incident led to the death. The second section is represented in the output costs including the losses caused by the productive services loss for the injured or dead persons in the accident; the cost of the disruption and traffic congestion as a result of the accidents; the transitional costs, such as costs of recruiting and training the alternative individuals to those injured in the accidents. The third section is represented in the social and psychological costs that are reflected upon the individual's vision to risk and safety. On the other hand, the study has identified five major types of costs resulting from traffic accidents which are the Loss of life and life quality, medical treatment, the cost of property damages, the costs of the legal system, and the output losses (Barnett and et. al., 1999).

In contrast, other studies has sought to estimate the value of life loss and the psychological and moral harms of the injured people in a traffic accident, which is known as The Value of a Statistical Life (VOSL), or what is known as the Value of Preventing Statistical Fatality (VPSF). Although economists are accustomed to use these statistical indicators, but so far they don't agree on the methods of calculating them. However, there are three common methods to calculate and estimate these indicators. The first method is represented in the Implicit (Political) Values Approach, which is the approach that is based on calculating the values that reflect the political decisions associated with new projects related to health, safety and others. The second method is The Human Capital (lost output) Approach, which measures the value of an individual's life by estimating the size of productivity losses caused by his death. Assuming that the output losses reflect the decline in the marginal productivity in employment; then, the value of life is measured by

the discounted value of the individual future income. The third method is represented in the approach of the Economic Welfare Theory, such approach which is based on the assumptions of economic welfare and the assumptions of other benefits, which are used in the cost-benefit analysis, which determines the extent of the individuals' "willingness-to-pay" for the additional changes of the risks arising from incidental or unintentional death compensations (Hills and Jones-Lee, 1983).
(Transport Research Laboratory, 2003) also pointed out that Dawson in 1967 estimated the net loss in the output, such as the net loss in the consumption of goods and services. This led to negative values of the non-producers in the community, such as prisoners and housewives. To overcome this, it was allowed to add losses of pains, sorrows, suffering, or human cost to the estimated cost. The use of an amount that reflects these social costs has become necessary in estimating the accidents costs in the United Kingdom. Table 1. shows the human costs expressed as a percentage of the gross costs of serious road accidents in Britain.

Table 1: Human costs (or equivalent) as a percentage of the total fatal crash cost
Great Britain

Period	Cost methodology	Percentage
63-67	Human Capital (net)	62
68-76	Human Capital (Gross)	30
77-78	Human Capital (Gross)	40
79-85	Human Capital (Gross)	28
1986	Human Capital (Gross)	48
87- 1999	Willingness-To-Pay	65

Source: Transport Research Laboratory, Guidelines for Estimating the Cost of Road Crashes in Developing Countries, *Department for International Development Project R7780*, London, May, 2003.

The serious and minor accidents models are so much similar to the estimates of table 1. Therefore, the component of pain, grief and suffering of serious accidents, which was less than 32% at the beginning of the nineties, amounted to about 80% in light of the human cost approach when adopting the willingness-to-pay approach. Also, those components for minor accidents which were estimated at 6 to 14%, reached about 66% according to the human cost approach when adopting the willingness-to-pay approach.
Transport Research Laboratory (2003) has reviewed the methodology used to estimate the costs of serious accidents in 11 countries of the European Union. The analysis has concluded that only four of them used the willingness-to-pay approach in estimating the human cost, while seven of them have not used it, but have determined the loss in the productive capacity, but two of them (Germany and Norway) were not able to get human costs.

Table 2: Human costs as a proportion of the total fatal casualty cost for a crash in European countries

Country	Method for Human costs	loss productive capacity %	Human cost %	Other costs (%)	Total cost ECU (1990)
Spain	Human costs estimated as 50% of production loss.	66	34	<1	170,989
Belgium	Court compensation payments	95	4	<1	398,815
Austria	Insurance payments for pain, disfigurements and permanent damage	99	-	<1	592,640
Germany	-	100	-	<1	670,776
United kingdom	Individual Willingness-To-Pay	29	71	<1	931,274
Sweden	Individual Willingness-To-Pay	46	54	<1	956,110
Finland	Social Willingness-To-Pay, calculation based on welfare payments	39	61	<1	1,414,418
Switzerland	Social Willingness-To-Pay, crash prevention costs in industry and other sectors related to acceptance of risk	38	62	<1	2,165,560

Source: Transport Research Laboratory, Ibid.

In table 2, it is noted that the gross social costs have risen significantly in the countries that have used the willingness-to-pay approach, and the human cost also has significantly increased in those countries. In addition, the human cost has increased than the loss in the output in the countries that have used the willingness-to-pay approach. It is also clear that for those countries not using the Willingness-to-Pay method, but including a sum to reflect 'pain, grief and suffering', values ranged from four to seven% of total costs in Belgium and France, to 67%in Denmark, where the values were assigned on a purely political basis.

The study has made comparisons between the values of the human costs in 1990 and 1999 in the eleven countries. It has concluded that the human costs reached about 1.3% of the total cost in Germany in 1999, even though it was equivalent to zero in 1990. In Austria, there were no human costs in the two years. In Switzerland in 1999, the human costs decreased by changing the willingness-to-pay approach into payment equivalent to the fixed judicial compensations, such that the costs of the serious accidents decreased to around 50% in 1999 from what they were in 1990.

Zaid Al Rummani (2007) has indicated that road accidents have competed losses resulting from cancer and heart disease. For this reason, most countries calculate the economic losses of road accidents. Although the method followed may change from a country to another, but the elements to calculate those losses remain fairly constant. The most important of those elements are: the loss of labor wages, medical expenses, the cost of insurance procedures and the cost of private and public property damage. Some add another cost to the previous elements represented in the loss of the society in general, owing to the shortage of the productivity, as a result of the death or the disability of a person.

3 Methodology

3.1 Willingness-to-pay Approach

As this study is concerned with estimating the amount of human losses owing to road accidents on the national level, it seeks to measure and estimate the impact of these accidents on the community, and after the initial review of all theories and the recognizable scientific approaches of this research point, the study suggests to adopt the willingness-to-pay approach in estimating the human cost, through estimating the value of life.

The willingness-to-pay approach includes estimating the individuals' willingness to deduct their resources to reduce the risks to an acceptable level. In other words, this approach seeks to differentiate between the risk level and the economic resources measured by the Marginal Rate of Substitution of Wealth instead of the Risk of Death or Injury. The willingness-to-pay approach in traffic accidents reflects the unremitting endeavors to statistical avoid the loss of life and consequently the reduction of serious effects of such accidents. Hence, it can be said that the willingness-to-pay approach minimize the risk not only for an individual or a limited number of individuals, but for all people in the community, rather than being an approach that preserve the life of a particular individual.

In light of this approach, the process of estimating the human costs of accidents is based on the cost calculation of three major categories, including individuals who use roads and are exposed to the risk of traffic accidents, family, relatives and friends of individuals at risks of accidents and the rest of the community that is affected by these risks.

The willingness-to-pay approach is considered one of the attractive approaches, but it, at the same time, involves a lot of problems, especially when it is sought to apply in the developing countries, due to the lack of accurate and detailed data. To estimate the cost in light of this approach, there is a need to three main estimates: the Risk of Road Accidents or the Risk of Injuries, the Risk Elasticity, Economic Assessment, and the Economic Valuation. Each can be characterized as follows (Asian Development Bank-Association of Southeast Asian Nations):

The Risk of Road Accidents or the Risk of Injuries: these risks are estimated through the shapes and ways used by the individual to transport (on foot, by cars, bicycles or others), the types of cars (with one engine, two wheels, three wheels, four wheels, or others) and the characteristics of road users (age, gender, etc.). This is often done through the division of accidents or injuries according to the level of the injury cruelty.

Risk Elasticity: The Risk Elasticity describes the changes of the risks associated with the other road users, and it is often measured by the probabilities of the accidents occurrence per million kilometers crossed by a vehicle. In spite of the difficulty of reaching the values of elasticity, they are important and required for various types of injuries and cars.

Economic Evaluation: it is a combination of cost components, such as losses in GDP, health costs, administrative costs, and loss of property, and includes the human value.

Malaysia is considered one of the leading countries that used the willingness-to-pay approach as a pilot experience for a developing country. Perhaps the success of this approach in Malaysia is what encouraged this research paper to be applied in KSA as a significantly growing country. Noteworthy is the difference between the willingness-to-pay approach and other common approaches from several aspects that some of which may cause non-acceptance in the environments of many countries. However, this approach,

since the beginning of the nineties, has gradually started gaining great acceptance in the researches of accidents costs evaluation in many countries, as it has emerged as a suitable approach for the evaluation of goods (such as a strong reduction of the risks of death) during the absence of data from the current market.
This research uses the willingness-to-pay approach in estimating the human cost of traffic accidents through measuring the value of life. In order to achieve this aim, the research depends on a field survey of road users, who are exposed to the traffic accidents' risk; as well as conducting an office research, to find out the previous literatures in the estimation of human costs resulting of road accidents.
The research will depend on using a questionnaire form prepared for this purpose. This form was used by major previous studies in this field; notably the studies of (Jones-Lee and et al., 1985 and 1993), that conducted a comprehensive survey in the United Kingdom. However, this research will enter some modifications required by the local environment data. It is planned to set up a questionnaire form such that it will be filled within 5-7 minutes.

3.2 Sample

This study focuses on all Saudi individuals residing in Riyadh from motorists licensees. As the number of these individuals is up to about more than 500 thousand persons, The study will be to pull the stratified random sample representative of the study society.
The study has identified a sample size of about 385 persons, randomly selected according to residences enrolled in Riyadh, and age of the group set that lie between 18 to 65 years, and finally by the type of the profession or job, in order to facilitate the coverage of different income categories of the society.

3.3 Questionnaire

The questionnaire acts as a medium to elicit out people's WTP. The questions prompting on WTP is designed and formatted in such a way that the result can be analyzed and interpreted using the Value of a statistical life method.
The questionnaire includes many questions which explores three main aspects; Assess the likelihood of exposure to accidents (to estimate Marginal Rates per capita, for substituting wealth for serious accidents), perception questions (to test the perception of risk at the individuals, and their understanding of the concept of risk occurrence possibilities), and some other demographic aspects.
The Marginal Rate of Wealth Substitution will be estimated instead of the Risk of Death, through the amounts that the respondents accept to pay in order to reduce the risk of death. This rate can be calculated via dividing the willingness-to-pay by the change in the risk of death probabilities, as shown by the following equation:
Marginal Rate of Wealth Substitution = Willingness-to-pay size/ Risks of death probabilities
This rate is known as the Value of a statistical life.

4 Estimating the Life of Road Accident in KSA

Out of 385 respondents who were sent correspondences, 148 were responded with a response percentage of 34.4%. Some surveyed refused to answer the questionnaire, for reasons of religion, because they assume it is not permissible to measure the probability of death.

As for those who answered the form questions, their answers were correct to a large extent, which means that they understood the concept of the probability of risks, which was aimed to be questioned by the survey.

Demographic characteristics of the sample

Table 3: Demographic characteristics of the sample

Statement		frequency	%
Age			
	From 18 to 30 years	88	60.3
	From 30 to 45 years	49	33.6
	From 45 to 60 years	6	4.1
	More than 60 years	3	2.1
Education			
	Illiterate	2	1.4
	Elementary or preparatory	7	4.8
	Secondary	27	18.6
	University degree or above	109	75.2
Income			
	Less than 3,000 SAR	44	31.9
	From 3,000 to 6,000 riyal	21	15.2
	From 6000 to 10,000 SAR	53	38.4
	Higher than 10,000 SAR	20	14.5
Number of children			
	One child	21	16.7
	From 2 to 3 children	57	45.2
	From 3 to 5 children	32	25.4
	More than 5 children	16	12.7
Number of cars			
	One car	40	27.4
	From 2 to 3 cars	37	25.3
	From 3 to 5 cars	44	30.1
	More than 5 cars	25	17.1

The study sample was distributed as shown in Table 3., where the majority of the sample observations occurred in the group age of 18 to 45 years. Moreover, the major percentage ratios were the holders of the secondary education level and the university level and above. Perhaps the most important element was the income level, which was distributed closer to the normal distribution among individuals from small to medium to large range incomes. Therefore, the main element which was the number of cars owned by the individual or his family was normally distributed.

Traffic accidents history among the sample respondents

Regarding the question about the history of traffic accidents at the family, it was noted that about 70.9% of the total respondents have been exposed whether them or any of their family members to traffic accidents, but the individual has witnessed at least one traffic accident with his family.

Table 4: The extent of family exposure to traffic accidents

Statement	frequency	%
Yes	104	70.9
No	43	29.1
Total	147	100

However, because not all traffic accidents are on the same degree of risk, it was necessary to ask about the degree of injury suffered by the individual or one of his family members in the traffic accident. The results indicated that a percentage (81.7%) of the injuries lie between minor to the lack of injuries, while 10.3% of the total respondents who have answered that they have been subjected to a traffic accident, that their degree of injury have reached the extent to death, and 7.9% of them have been in serious injuries. This indicated that about 8.8% of the total respondents have been or one of his family members exposed to a fatal traffic accident, while 6.8% of them have suffered serious injuries as a result of their traffic accidents.

Table 5: Degrees of injury

Statement	frequency	%
Death	13	10.3
Serious injuries	10	7.9
Minor injuries	45	35.7
No injuries	58	46
Total	126	100

4.1 The Application of the willingness-to-pay approach in KSA

The most important part of this study is to estimate the cost of life of individuals in the community. This study tends to determine the value of this life through the estimations of the individuals themselves by measuring how much they are willing to pay for preserving their life or not facing traffic accidents.

4.1.1 The Experiments of measuring the costs of the road accident in KSA

Recently, the High Commission for Riyadh city development has conducted a number of studies to estimate the costs of accidents, in order to put a strategy for traffic safety in Riyadh (High Commission for the Development of Riyadh), where the report of the Commission has indicated that the estimates prepared by Alkhoashki, specify the following values for the costs of accidents in KSA:

Table 6: Estimation costs of the road accident in KSA in Previous studies

Article	Cost in SAR (1995)
The cost of accidents in KSA based on the study of Alkhoashki	SAR 7 billion
The cost of accidents in KSA according to the study of National Transportation	SAR 18 billion
The cost of accidents in KSA according to the Australian estimates	SAR 18 billion
The cost of accidents in KSA according to the US estimates	SAR 41 billion

These values indicate that there are significant differences in the estimates, according to the used approach, where the loss ranges from 2.2% to 4.7% of the GNP in case of defining an upper limit to estimate the cost of accidents, and in an average level of SAR 21 billion Saudi.
This study is considered one of the studies that have emphasized the importance of using modern approaches in the Kingdom, to estimate the cost of accidents, such as "the willingness-to-pay" approach.

4.1.2 Measuring the probability of exposing to road accident

By asking about an individual probability of facing a fatal traffic accident, the answers have indicated that about 28.4% of the total respondents believe that it is unthinkable to face fatal accidents, while only 7.1% of them believe that there is a high probability of their exposure to fatal traffic accidents.

Table 7: What are the probabilities of your facing the risk of fatal traffic accidents?

Article	frequency	%
Unthinkable probability	40	28.4
Low probability	51	36.2
Average probability	40	28.4
High probability	10	7.1
Total	141	100

The most important question was about the extent that the respondents are willing to pay for reducing the risk of death resulting from exposing to traffic accidents regarding them or any of their family members to a ratio of 50%. The answers were that 18.2% of them are not willing to pay any amount, while 6.8% of them are willing to pay from 1 to 120 SAR for reducing these risks by 50%. In addition, 23.6% of the total respondents have expressed their willingness-to-pay from 121 to 480 SAR to reduce these risks by 50%. It should be noted that the proportion of 51.4% have expressed their readiness to pay more than 481 SAR for reducing this risk by 50%, and even 18.2% are willing to pay 2000 SAR and more.

Table 8: How much are you willing to pay to reduce the risk of your death in road accidents by 50%?

%	frequency	Amounts in Riyals
18.2	27	1
2.7	4	60
4.1	6	120
5.4	8	240
12.2	18	360
6.1	9	480
4.7	7	840
28.4	42	1200
18.2	27	2000
100	148	الإجمالي

4.2 Estimation of the Value of a Statistical Life

This section estimates the marginal rate of substitution of wealth by personal risks through the values that the respondents have agreed that they are willing to pay to reduce the risk, which can be calculated by dividing the magnitude of willingness-to-pay on the change in the risks of death probability, for all respondents.

The research here estimates the marginal rate of substitution of wealth by the risks of life, or what is known as the Value of a Statistical Life, according to the visions of the respondents to the amounts they are willing to pay to reduce risks, which can be measured by dividing the willingness-to-pay on the change in the risks of death probability (Yusof and Nuura, 2009):

The Marginal Rate of Substitution = the Willingness-to-pay/ the change in the risks of death probability

It is often referred to as: the value of a statistical life is the change in the wealth to the change in the risk. Sometimes, the value of a quality-adjusted life year (QALY) is measured as a scale to calculate the value of a statistical life.

Table 9: Estimating the marginal rate of substitution of wealth by death risks (Reducing death risk by 50%)

Question	The number of cases	Mean in Riyal	Median in Riyal
Monthly Willingness-to-pay	147	140	177
Annual Willingness-to-pay	147	1681	2120
The change in death risks	50%		
The marginal rate of wealth substitution	147	3,361,224	4,240,105

Table 9 shows the results of the marginal rate of substitution of wealth by the risks of death, or what is known as The Value of a Statistical Life, where the amounts show both the Mean and the Median. The amounts of the Mean from all the answers are estimated by SAR 3.4 million comparing to the Median value which is estimated by SAR 4.2 million.

According to the table, it is clear that the Median value exceeds the value of the Mean. This may be due to the effect of outliers in the upper tails of the distribution. Nevertheless, the difference between the Mean and the Median values is still not that big. By observing the difference between the Mean and the Median, it is natural to that considering the explanation of these measures of the central tendencies that can use the Value a Life. Miller and Guria (1991) suggest that the median is the best estimate, if the survey does not weed out high values. But if these have been weeded out, the mean is more reliable. For KSA, the average value is the most appropriate and consistent with the analysis of costs and the social benefits, in a similar way to the case of Malaysian society, because of many aspects of economic similarities between them (in terms of the stage economic development as countries with the highest growth). If we are going to choose one value with confidence and significance, then the SAR 3.4 million may be a suitable estimate to calculate the value of a statistical life for the car drivers in KSA.

4.3 The Cost of the Life Loss in KSA

By estimating the value of the lost life with about SAR 3.4 million, the state lost SAR 7.5 billion in 2003. In 2003, the Gross domestic product (GDP) reached SAR 385.7 billion in KSA. Therefore, the cost of the lost lives as a result of road accidents was equivalent to 2% of GDP in 2003.

Table 10: the cost of the life loss as a result of traffic accidents

Year	Population	The number of road fatalities	The Value of a Statistical Life in Riyal	The Overall cost of the life loss in riyal
2006	24,121,890	11,820	3,361,224	39,728,752,830
2007	24,941,298	12,221	3,361,224	41,078,317,806
2008	25,787,025	12,636	3,361,224	42,471,230,175
2009	26,660,857	13,064	3,361,224	43,910,431,479
2010	27,563,432	13,506	3,361,224	45,396,972,504
2011	28,376,355	13,904	3,361,224	46,735,856,685
2012	29,195,895	14,306	3,361,224	48,085,639,065
2013	29,994,272	14,697	3,361,224	49,400,565,984

The amounts indicated above represent the minimum limit of losses, as they took into account only the fatalities occurring as a result of only road accidents. These numbers will be higher, if they take into account all types of road accidents (whether accidents with serious injury, minor injury, or only damages) at the level of the Kingdom, because there are not any statistics developed for the separation of serious injuries, minor injuries, damages or other incidents. Thus, the value of serious injury loss is estimated by about 10.0% of the value of lost life, which is equivalent to SAR 336.1 thousand.
The value of minor injury is estimated by 1.0% of the value of the lost life, which is equivalent to 33.61 thousand SAR. The value of the damages only as a result of accidents is estimated by 0.1% of the value of the lost life, which is equivalent to 3361 SAR.
As the official statistics indicate that the number of road accidents in KSA has reached about 589.3 thousand accidents, and resulted in about 41.1 thousand patients, and as there is no explanation of the extent of seriousness these injuries, this research will depend on

the relative importance estimates of the seriousness of the injuries distribution in the Kingdom, as serious injuries rates are estimated by about 19% of the total injuries in the Kingdom, against 81% of minor injuries.
With these estimates, the overall cost of road accidents in KSA can be calculated as shown in the following table:

Table 11: The Cost of Road Accidents in KSA according to2013 AD statistics

Statement	Number	The value of the incident cost in SAR	The cost in riyal
Fatalities	14,697	3,361,224	49,400,565,984
Serious injuries	7,809	336,122	2,624,780,204
Minor injuries	33,291	33,612	1,118,985,245
Only damages	533,503	3,361	1,793,222,699
Total			54,937,554,132

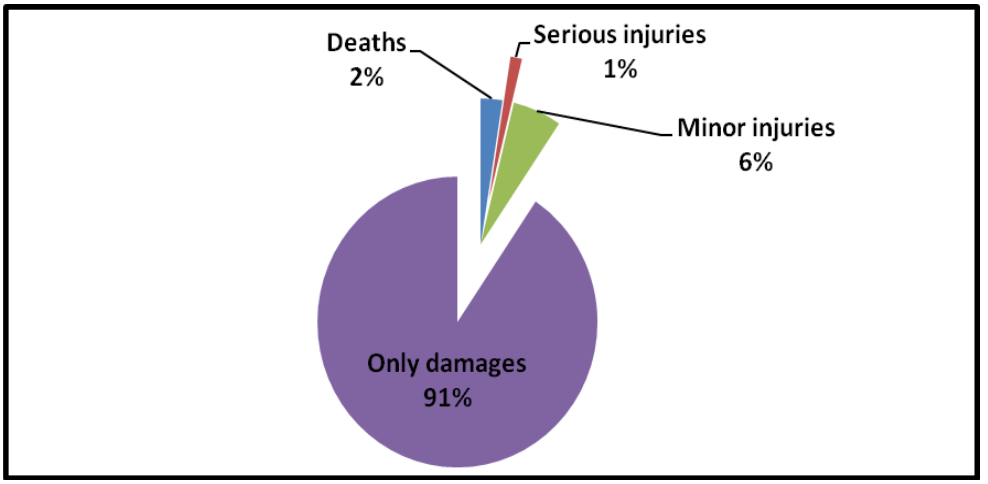

Figure 2: the relative importance of the number of road accidents in KSA in 2013

It should be admitted that the shown estimates still presenting the minimum limit of losses, because of not reporting all cases of road accidents in the police, with justifications for hiding, as the reports rate in the country is unknown. Therefore, the estimated losses are possible or potential in the country.

4.4 Comparing the Results of the Study with the Previous Studies

The table below shows the results of the losses estimates, caused by road accidents, indicated in the various previous studies, comparing to the results of the current research:

Table 12: Comparing the results of the study with the results of previous studies of the Kingdom

Statement	The cost of traffic accidents in billion SAR	The population in million people	GDP at constant prices in billion SAR	The number of fatalities	The value of a statistical life of the individual	The ratio of accidents to the output %
The cost of accidents in the KSA based on the study Alkhoashki	7.0	18.13	557.6	8,887	787,679	1.3
The cost of accidents in KSA by the National Transportation Study	18.0	18.13	557.6	8,887	2,025,459	3.2
The cost of accidents in KSA by the Australian estimates	18.0	18.13	557.6	8,887	2,025,459	3.2
The cost of accidents in KSA according to the US estimates	41.0	18.13	557.6	8,887	4,613,546	7.4
The cost of accidents in KSA according to the estimates of current research	54.9	29.9	1,272.4	14,651	3,361,224	4.3

The estimates show that the results of the current search are located in the middle area between the results of the American and Australian international estimates, as the value of life in the American estimates was about SAR 4.6 million compared to SAR 2.0 million in the Australian estimates. This increases the confidence in the results of this research, where the value of life amounts to about SAR 3.4 million. Regarding the overall cost of the losses, which amounts to about SAR 54.9 billion, it is considered much less than the American estimates, which came in the statistics of 1995, amounting to about SAR 41.0 billion. By re-calculating it in the prices of 2013, the estimated loss value in this research is considered logical and acceptable. The ratio of the cost loss to GDP confirms that the estimation results of this research are appropriate with the prices of 2013, as the percentage of these costs to GDP amounted in real values to about 4.3%, comparing to 7.4% in the US estimates and about 3.2% of the Australian estimates.

4.5 International Comparison

Many governments of the developed countries, for example, Australia, New Zealand, Sweden, Switzerland, United Kingdom, and the United States, have begun using the willingness-to-pay approach as a basis to the official economic evaluation of a statistical life. Table 13. shows a list of the mean of the Value of a Statistical Life for a number of developed and developing countries. It shows that the proposed value of about SAR 3.4 million in KSA as the value of a statistical life is relatively low compared to the estimates of the other developed and developing countries.

Table 13: The Estimated Values of a Statistical Life according to the country

Country	The value of a statistical life in million riyal
World average	7.1
Australia	6.7
Austria	8.8
Canada	9.2
Sweden	4.6
Taipei, China	3.1
United kingdom	7.6
United States	6.9
New Zealand	3.6
Malaysia	1.2
KSA(the current search)	3.4

Source: Asian Development Bank-Association of Southeast Asian Nations , The Cost of Road Traffic Accidents in Malaysia, *Regional Road Safety Program, Accident Costing Report, AC 5*, Malaysia.

5 Conclusion

This research has adopted the application of the willingness-to-pay approach through a survey list, depending on the field survey methodology. The value of a statistical life has been estimated in KSA with a Mean of SAR 3.4 million, compared to a Median amounted to SAR 4.2 million. This study has estimated the cost of the life loss in KSA of about SAR 49.4 billion, compared to the estimation of traffic accidents costs in general, including the fatalities, injuries (containing serious and minor injuries together) and damages at an amount of SAR 54.9 billion.

The research results can be used to help the decision-makers to regard the traffic safety improvement, and to estimate the costs of losses caused by the fatalities, injuries and damages in a logical and reliable way, by estimating the value of a statistical life as an acceptable entrance to the decision making process. With the amount of ignoring the benefits of preserving the lives of car drivers in the past as a result of the lack of reliable estimates, the results of this research (if applied by decision-makers); will lead to the allocation of more funds to improve traffic safety on the roads. Unlimitedly, improving the safety of car drivers on the roads will have desirable effects on the quality of Saudis' life as a whole.

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