Estimating the Cost of Road Traffic Accidents in Iran using Human Capital Method

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Abstract

Road traffic accidents and the effects they subsequently incur are increasing dramatically, and estimating the cost of road traffic crashes could be a vital step in improving the recognition of this widespread problem. The main objective of this paper is to estimate the cost of road traffic crashes in Iran using the Human Capital (HC) Method. Results of this study indicate that the cost of road traffic crashes in Iran for the year 2009 was approximately 114,455 billion Iranian Rials (about $US 11.458 billion), which accounted for 1.41% of Iran's Gross National Product (GNP) in that year. This study shows that lost output and property damage account for the largest proportion of this cost, whereas human, administration and medical costs are the next highest contributors. In addition, this study estimates the cost of accidents in Iran for the year 2009, depending on their status as fatal, causing serious injury, slight injury and property-damage-only.

Keywords: Human Capital Method, crashes, costs, developing countries.

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1. Introduction

Road traffic crashes and their casualties are a serious threat to many people round the world. WHO [2009] states that road traffic crashes cause the death of more than 1.2 million people and the injury of between 20 and 50 million people annually around the world, while more than 90% of these deaths occur in low and middle income countries. Estimating the cost of road traffic crashes at a national level could highlight this problem, not only as a social concern, but also as an economic problem that imposes high and undesirable financial burden on the society. In addition, an estimate of the financial impact of road crashes quantifies the magnitude of this economic burden and the advantages that will arise from improving road traffic safety.

This concept appears to be of additional importance once it is arisen in developing countries, where there are often high numbers of traffic casualties and limited resources. This means that it is vital to assign funding rigorously and as expeditiously as attainable. ADB [2009] states that the cost of road crashes in developing countries accounts for between 1 and 3% of their annual GDP. As stated by WHO [2004], low and middle income countries incur annual costs caused by road traffic crashes that are more than the financial aid they receive for developmental purposes.

This research study aims to estimate the cost of road traffic crashes in Iran using the Human Capital (HC) Method. It is organized as follows; section 2 presents an overview of previous credible studies in this field, section 3 is a review of the methodology employed in this research to estimate the cost of road traffic crashes in Iran, section 4 introduces the data sources and assumptions applied in this paper, and section 5 shows the results from the estimation methodology. Finally, section 6 summarizes the results obtained from this research with a discussion and the conclusions.

2. Literature Review

Estimating the cost of road traffic crashes at a national level has a long history, with more than 70 years of research. In 1938, Jones estimated the cost of traffic crashes in the United Kingdom, after which crash costing studies continued and were developed by other researchers, such as Reynolds, Dawson, Jacobs, Miller, Ogden and Elvik [Dawson, 1967; Parry, 2003; Access Economics, 2011; Jacobs, 1995 and Elvik, 1995].

Reviewing previous studies shows that several key methods have been used for crash costing in various studies, and the more reliable and usually used techniques are summarized as follows [Silcock and TRL, 2003; ADB, 2009 and Ayati, 2005]:

• Human Capital (HC)
• Willingness To Pay (WTP)
• Life-Insurance Method
• Implicit Public Sector Valuation
• Value of Risk Change
• Court Award

There are some demographic-based limitations of these techniques. Some of the methods, such as WTP, Life-Insurance, and Implicit Public Sector Valuationand Value of Risk Change are based on the public's awareness of risk exposure and the consequences of traffic crashes as a probable social danger. Therefore, applying these methods in developing countries where the populace has less understanding of the risks concerned is not sensible or useful.

In the 'Court Award Method` the calculations include the sum awarded by a judge to the family of a deceased or injured party, not the life value or lost output of that person. One of the considerable shortfalls of this method is

considering the role of personal judgment in determining the coefficients. Also this method cannot cover all of the indirect costs of a traffic crash, such as emotional impact, social pressures and other costs that incur on the families of those involved, and wider society as a whole. Thus, this method is not ideal for the accurate estimation of the indirect costs of traffic crashes [Silcock and TRL, 2003; Mohan, 2002 and Ayati, 2005].

The HC method and the WTP method are the most prevalent and widely used techniques for estimating the cost of road traffic crashes. The HC method estimates the cost of road traffic crashes in terms of the lost earnings incurred by the casualties, whereas the WTP method estimates the cost as the amount that individuals are willing to pay to reduce the risk of experiencing a road traffic carsh [Ismail et al 2010]. The difference between HC and WTP depends on the goals or priorities of members of the society, and also the availability of data. If the main concern of a research study is to maximize the national output, then the HC method is more suitable, whereas the WTP method is the best choice when the aim is to improve social welfare by improving the road safety. Furthermore, the availability of data for the WTP method is another limitation in developing countries which makes the HC method a more attractive choice in this case [Jacobs, 1995].

The WTP method has been adopted in several developed countries such as USA, UK, New Zealand and Sweden for estimating the cost of road traffic accidents. Elvik [1994] divided the costs of traffic crashes into five main categories, which were medical costs, lost output costs, lost quality of life, property damages and administrative costs. In another study, Elvik [1999] used the WTP method to find that the cost of lost quality of life accounts for over half of the total cost of traffic crashes. Miller [1993] split the total human costs of road traffic crashes into lost quality of life costs and financial costs, in a similar manner to the WTP method of estimation. In 2002, Miller and his colleagues used the WTP method to estimate the costs of traffic crashes in the USA as accounting for more than 2.3% of its total GNP. Lost output and property damage were the two major components of their estimated costs, comprising 26% of the total [Elvik, 1995; Parry, 2003; Risbey et al., 2007].

On the other hand, despite the advanced data requirements and goals of the HC method, it has been adopted in several crash costing studies in developing countries, such as Jordan, Egypt, Indonesia, Ghana, South Africa, Bangladesh, India, Vietnam, the Philippines and Thailand [Downing, 1997; Mohan, 2002; ADB-ASEAN, 2009; Economics Circle, 2001; Al-Masaeid et al., 1999; De Leon et al., 2005; Ismail et al., 2010 and Anhet al., 2005]. Furthermore, this method has also been used to estimate the cost of traffic crashes in some developed countries, such as Australia, Canada, Germany, Norway, Portugal, Japan, Australia and Austria [Access Economics, 2011; R Elvik, 1995 and Risbey et al., 2007].

Several studies are conducted to estimate the cost of road traffic crashes in Iran in recent years. Ayati [2002] estimates the cost of rural roads traffic crashes in Iran more than 6100 billion Iranian Rials in 1997. Ayatis study divides the cost of traffic crashes into 5 cost-components, which are fatalities and human costs (58.4%), property damage (28.3%), administrative costs (9.7%), medical costs (2.9%) and lost-time costs (0.7%). Zahed and co-authors. [2005] used the V.S.L. method to estimate the cost of rural fatalities and permanently disabled casualties accounted for between 0.3 and 2.2 percent of Iran's GNP in

1999. Further to this, Ayati [2005] estimated that traffic crashes in Iran cost around 3.8% of its GNP. In this study, the rate on investment return in road safety improvement projects in Iran was calculated at more than 360%. Ayati and Ahadi [2007] discuss the costs of lost-quality-of-life resulting from traffic crashes in Iran, and they estimate the costs of fatalities and permanent-disabilities in 2004 to be between 1598 and 2397 million Iranian Rials. Ayati and co-authrs [2008] estimate the cost of traffic crashes in Iran in 2004 to have been more than 1093152 billion Iranian Rials. In addition, they determined the cost of damage to vehicles on rural roads to be 56.7 percent of the total cost of crashes in that year. Ayati [2009] goes on to assert that the cost of traffic crashes on rural roads in Iran in 2004 was over 5725 billion Iranian Rials. This study divided the cost of traffic crashes into 9 categories, where the costs of fatalities and lost-quality-of-life (65.59%) and administrative costs (14.4%) account for the major cost components. This study used the Court Award Method to estimate the lost-output costs of traffic crashes.

Overview of previous studies in Iran shows that there have been a limited number of endeavors to estimate the costs associated with road traffic crashes. Furthermore, each of these attempts has some limitations. All of the studies have data deficiencies in their methods of estimation. Moreover some of them suffer from lack of straightforward methodology. Other studies are limited in that they focus on limited cost-components. This paper aims to estimate the cost of road traffic crashes in Iran with an integrated and well-supported framework. Therefore, this paper introduces a detailed and comprehensive methodology to estimate the cost of road traffic crashes in developing countries, which can be modified and updated according to the availability of data sources.

3. Methodology

This study adopts the Human Capital Method to estimate the cost of road traffic Crashes in Iran. The methodology of present study is extracted from [ADB, 2009; Silcock and TRL, 2003 and Ayati, 2009]. The HC method is based on the summary of all costs relating to, or arising from, a crash. Among different variations of the HC approach, the Gross-Loss-of-Output is the easiest and most frequently used technique. In this method, cost of the accident is calculated as the present value of the potential earnings that could have been acquired by the injured or deceased person, if the accident had not occurred [Ismail et al., 2010].

Therefore this research study adopts the Gross-Loss-of-Output of the HC approach to estimate the cost of road traffic crashes in Iran for the year 2009. To this end, the total cost of road traffic crashes is categorized into three main sub-costs, each of which includes some cost-components. The classification of traffic crashes and their related sub-components is specified in Figure 1 and Table 1.

Each of these cost-components covers specific parts of the direct and indirect costs of a road traffic crash. Property-damage costs cover the damage that occurs to vehicles, roadside properties and goods carried in the vehicles. Casualty-related costs include medical costs, human costs and lost-output costs. Medical costs refer to the finances required due to injuries occured in crashes, and human costs cover the indirect effects of crashes, such as suffering, bereavement and other adverse effects on the quality of life. Lost output refers to the loss to the economy of the productive capacity of those affected by crashes. Finally, administrative costs consist of police services, insurance

companies, court costs and other administrative costs incurred due to traffic crashes [Silcock and TRL, 2003; ADB, 2009 and Ayati, 2009].

4. Data and Assumptions

Estimation of the cost of road traffic crashes at a national level requires a variety of data and statistics. However, the available raw data regarding the road safety situation in Iran is limited to the number of road traffic crashes, road fatalities and road injuries. The available data of Iran`s road safety statistics in the last 4 years is presented in Figure 2 and table 2 [INRSCS, 2011].

For other necessary data items that are unavailable, the corresponding values in other related studies in Iran is used. This research paper will use parallel available data items accounting for the inflation rate. Other required

data items that are not available in national studies are estimated using the assumptions provided in credible international related material. These assumptions are presented and described as follows:

A. Assumptions for Estimating the Cost of Property Damage

Property damage costs cover the damage that occurs to vehicles, roadside properties and goods carried in the vehicles as a result of crashes. To estimate the cost of property damages, it is necessary to determine four other data items as well as the total number of traffic crashes. These additional pieces of data are the distribution of damage to vehicles, the number of damaged vehicles, the rate of crash underreporting and the cost of damaged goods and roadside properties. To estimate the number of damaged vehicles, the average number of involved vehicles per crash is ob-
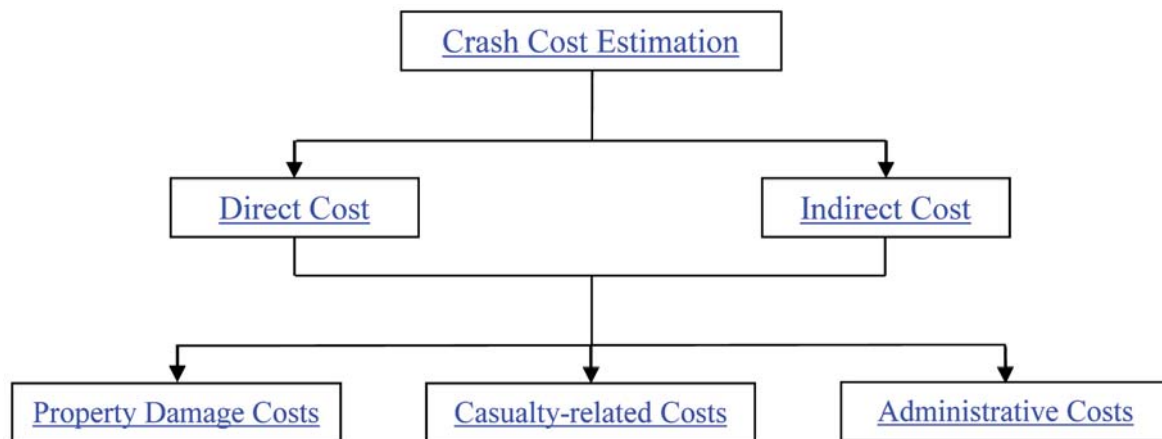

Figure 1. Cost estimation of traffic crashes by 'Human Capital' method

tained from [Ayati, 2005] and multiplied by the number of crashes in 2009. The distribution of damaged vehicles, which considers the severity of the damage, is estimated according to the results of Ayati and co-authors [2008], and these values are assumed to be the same for all the severity levels of crashes. The average costs of damage for public properties and different types of vehicles are calculated by applying the inflation rates (2009) to the equivalent figures in Ayati [2009]. As stated in [INRSCS, 2008], to estimate the actual number of vehicles involved in road crashes in Iran in 2009, the number of Property-Damage-Only crashes is multiplied by 1.10 to cover the underreporting of accidents to the police. Finally, to account for the value of goods that may be carried by the damaged vehicles and roadside properties, %5 of the value of the damaged vehicles is added to the total damage cost [Ayati et al. 2008].

Table 1. Cost classification of traffic crashes in the 'Human Capital' method

Classification of Traffic Crash Costs	Sub-Costs of Traffic Crashes	Explanation
Property damage Costs	Costs related to property damage	Damage caused to vehicles, Objects and animals
Casualty-related costs	Medical costs	Medical costs for a slight injury
		Medical costs for a serious injury
	Lost output costs	Lost output of others involved
		Lost output for a slight injury
		Lost output for a serious injury
		Lost output for fatalities and those permanently disabled
	Human costs	Human costs of a fatal crash
		Human costs of a crash causing serious injury
		Human costs of a crash causing slight injury
		Human costs of a crash causing property damage only
Administrative costs	Administrative costs	Costs of Police, Churches and other institutions

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B. Assumptions for Estimating the Cost of Lost Output

Lost output is one of the cost-components of casualty-related costs, which refers to the loss to the economy of the productive capacity of those affected by crashes. It is typically the largest casualty-related cost sustained in developing countries, and can range from one day for slightly injured casualties, to decades of lost working time for a person who is killed or permanently disabled in a crash [Silcock and TRL, 2003; ADB, 2009]. The two main types of data that are required for costing of lost output are the average wages of casualties and the amount of lost time.
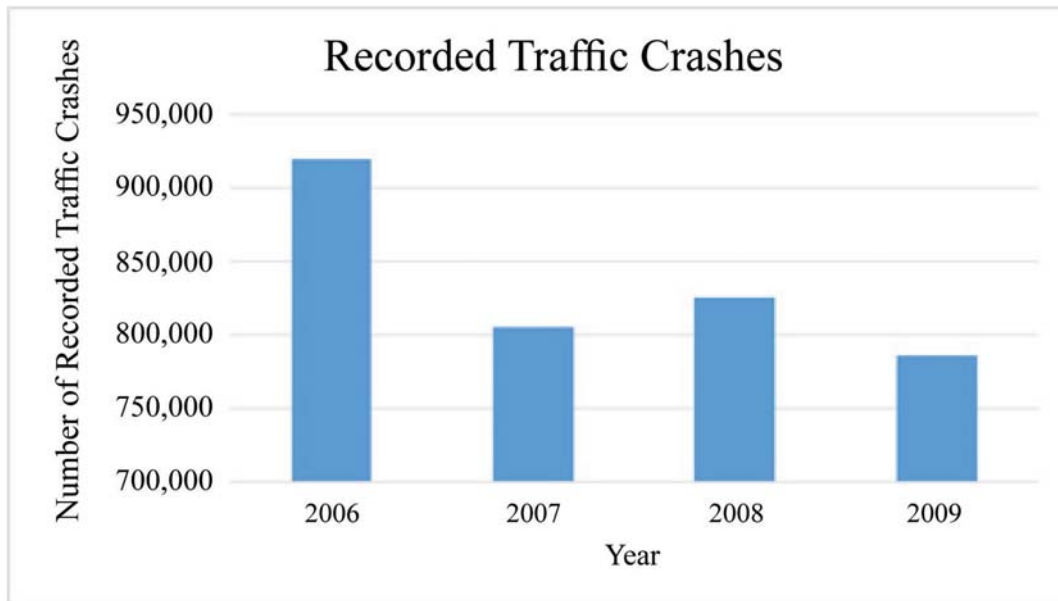

Figure 2. The number of road traffic crashes (2006 - 2009)

Table 2. The number of road traffic crashes and associated casualties (2006 - 2009)

Year	Traffic Fatalities	Traffic Injuries
2006	27,567	553,234
2007	22,918	550,714
2008	23,362	718,008
2009	22,974	806,922

To estimate the amount of lost time due to traffic crashes, three different aspects should be considered, which are lost time of injured parties, lost time for fatal casualties and permanently disabled persons and lost time of others involved in the crash [Silcock and TRL, 2003]. To estimate the average lost time for different casualty types in Iran, the results of the study by Ayati [2005] and suggestions by [TRL] are used. The lost time for others affected by crashes, depending on the type and severity of the crash, is obtained from Ross Silcock and TRL [2003] and Ayati and Ahadi [2007]. The average lost years of a permanent-disabled or a deceased individual involved in a road traffic crash is estimated at 23 years and 243 days (23.67 years) according to data obtained from INRSC [2011]. Furthermore, those who are deceased or permanently disabled before reaching 21 years of age or after the age of 60, are not included in the estimates [Silcock and TRL, 2003; Ismail et al., 2010;Ayati, 2002].

To calculate the average wages of casualties and others affected by crashes in 2009, corresponding figures were obtained from Ayati [2009] by applying the inflation rates extracted from the Iran Central Bank. The lost output from a fatality or a permanently disabled person is calculated using the equation (1) which is suggested by Ross Silcock, TRL [2003] and De Leon and Co- authors [2005]

$$Loss = \sum_{n=1}^{N} \frac{W}{(1+r)^n} \quad (1)$$

In this equation, W is the average annual wage, g is the economy growth rate, r is the effective discount rate that reflects the decline in the working efficacy of a person as they age (equal to the economic discount rate minus the real income growth rate) and n refers to the years of lost output, which is 23.67 years in this study. Considering the average inflation rate and approximate income growth in Iran in the last six years, which are 15.65% and 10% respectively [INRSCS, 2011]; the discount rate (r) is calculated as 0.056.

C. Assumptions for Estimating Medical Costs

The medical costs incurred by those who are injured in crashes and their families, range from assistance given at the scene to medical care required during recovery or death. This may include first aid and rescue services (ambulance), hospital costs (food and beds, operations, x-rays, medicines, doctors) and rehabilitation costs (treatment and prosthetics) [Silcock and TRL, 2003]. As stated in Ayati [2009], which incorporates a comprehensive hospital survey in Iran in 2007, the injuries due to traffic crashes are categorized according to their severity in 18 classes. Based on this classification system, %84 of road crash injuries are slight injuries, while %16 of traffic injuries are serious which some of which are led to death. The average medical cost for each group is extracted from Ayati [2009] by applying the same inflation rates used in the last section.

D. Assumptions for Estimating Human Costs

Human costs refer to those indirect effects of traffic crashes that have emotional long-term impacts, such as suffering, bereavement and other adverse results on the quality of life. The human costs of road traffic crashes are estimated using the methodology suggested by TRL, where depending on the crash severity, a certain percentage of the total costs of traffic crashes are considered to be human costs. These are based on influence coefficients,

which specified as 0.2 for fatal crashes, 0.5 for serious injury crashes, 0.3 for slight injury crashes and 0.01 for property-damage-only crashes [Silcockand TRL2003; Anh et al., 2005].

E. Assumptions for Estimating Administrative costs

Administrative costs cover insurance companies, court costs, police services, and other administrative costs incurred due to traffic crashes. Administrative costs are typically low compared to other cost components of traffic crashes, and usually it is not worth to spend a lot of time and effort in calculating elaborate estimates. Contrary, police forces and insurance companies usually don't report their actual costs. Therefore this study uses the assumption of Ross Silcock and TRL [2003], which employs the average of the ratios of the administrative costs to the total costs in the crash-costing studies of other similar countries, using the HC method [Mohan, 2002; ADB-ASEAN, 2009; Economics Cir-

cle, 2001; Al-Masaeid et al., 1999; De Leon et al., 2005;Ismail et al., 2010; Anh et al., 2005]. Using this method, the ratio of administrative costs to the total costs is calculated as 6.16 percent.

F. Assumptions for Estimating the Costs of a Fatality, an Injury and a Property-Damage-Only (PDO) Crash

Estimating the costs of a fatal, serious injury, slight injury or a PDO crash is useful in the economic evaluation of road safety improvement studies and also in provincial allocations for road safety improvements. To estimate these costs, data regarding the average number of casualties involved in road traffic crashes in Iran, according to the severity of their injuries, is necessary. Considering the lack of available information related to this in Iran some corresponding figures of crash costing studies in similar developing countries are extracted and their average values are used in this research study (Table 4) [ADB-ASEAN, 2009; ADB-ASEAN, 2005; ADB-ASEAN, 2004; De Leon et al., 2005].

Table 3. Ratio of administrative costs to the total costs in various countries

Country	Year	Ratio of administration cost to the total cost
Egypt	2010	0.92%
Iran	2009	14.40%
Vietnam	2005	3%
Thailand	2005	4.20%
Myanmar	2005	5.20%
Brunei	2005	2.83%
Cambodia	2005	7.96%
Indonesia	2004	6.63%
Iran	2001	10.80%
South Africa	2000	5%
Argentina	1999	5%
Jordan	1998	8%

Table 4. The average number of casualties occurring in varying severities of road crashes in different developing countries

Country	Fatal Crash			Serious Injury Crash			Slight injury Crash		
	Fatalities	Serious Injuries	Slight Injuries	Fatalities	Serious Injuries	Slight Injuries	Fatalities	Serious Injuries	Slight Injuries
Thailand	1.16	0.48	0.43	-	1.25	0.41	-	-	1.72
Egypt	1.4	0.7	1.9	-	1	1.2	-	-	1.2
Myanmar	1.103	1.23	0.26	-	1.12	0.82	-	-	1.4
Singapore	1.04	0.13	0.36	-	2.17	0.67	-	-	1.27
Brunei Darussalam	1.17	0.38	0.26	-	1.43	0.3	-	-	1.53
Average	1.17	0.58	0.64	-	1.39	0.68	-	-	1.42

5. Results

This section presents the results of the study in three sections; in the first, the cost of road traffic crashes in Iran for the year 2009 and the portion from each cost-component are presented. Section 2 shows the estimated costs of a fatal, an injury and a property-Damage-Only (PDO) crash in 2009. As a result, in section 3, the ratio of the total cost of road traffic crashes in Iran to the Gross-National-Product (GNP) is presented and discussed.

A. Estimation the Cost of Traffic Crashes of Iran in 2009

Using the HC method to analyze the data previously discussed, the total cost of traffic crashes in Iran in 2009 and the value of each cost-component are estimated and presented in table 4. In addition, the cost of a road crash fatality and a road crash injury, and their associated cost-components in Iran for 2009 are presented in table 5. From table 5, it can be seen that road traffic crashes cost around 114455 billion Iranian Rials (about $US 11.42 billion) in the year 2009. The results show that property-damage-cost accounts for the largest percentage of the total (36.86%); lost-output-cost is the next biggest cost (8.22%); rest of them are human costs (16.18%); medical costs (12.60%), and administrative costs accounted

for 6.14% of the total.

Moreover, the estimated results show that a road crash fatality cost around 613.46 million Iranian Rials in 2009, a serious injury from a road accident cost 107.30 million Iranian Rials, and a slight injury cost 18.32 million Iranian Rials. A property-damage-only crash cost considerably less at 2.48 million Iranian Rials. More details and cost-components for each causality level are presented in table 6.

B. Estimation of the Cost of a Fatal, an Injury and a PDO Crash in 2009

This step of the study estimates the costs of a fatal, an injury and a PDO Crash in 2009. To this end, table 7 shows the total cost of road traffic crashes in Iran according to the severity level for the year 2009. Fatal crashes represent the main bulk of other severities of crashes.

The total average cost of a fatal crash in Iran for 2009 is around 903 million Iranian Rials (about $US 90.47thousand), while the average cost of a serious-injury crash and a slight-injury crash are about 273 million Iranian Rials (about $US 27.4 thousand) and 138 million Iranian Rials (about $US 13.82 thousand) respectively. Finally, the average cost for a property-damage-only crash is around 112 million Iranian Rials (about $US 11.2 thousand).

Table5. The value the of cost-components of road traffic crashes in Iran for the year 2009

Cost component	Estimated Value (Billion Iranian Rials)	Estimated Value (Billion US Dollars)	Percentage
Property damage	42,191.42	4.22	36.86%
Administrative costs	7,025.33	0.70	6.14%
Medical costs	14,419.50	1.44	12.60%
Lost output costs	32,296.66	3.23	28.22%
Human costs	18,522.29	1.85	16.18%
Total Cost of Road Traffic Crashes	114,455.19	11.42	100.00%

C. Determining the Ratio of the Total Cost of Traffic Crashes to the GNP

In this step, the ratio of the total cost of Iran road traffic crashes and the portion of each cost-component to the GNP are calculated for 2009. The Gross National Product (GNP) is the total value of goods and services produced by a country in a given time period, generally one year, based on current market prices (not allowing for the depreciation of certain goods and services) [Islamic Republic of Iran Central Bank, 2011]. According to the Islamic Republic of Iran Central Bank [2011], the GNP of Iran in 2009 was around $US 810.3 billion. Consequently, the total cost of road traffic crashes in Iran for the year 2009 is more than 1.41 percent of the Iran GNP (Table 8).

6. Conclusion and Discussion

This study uses the Human Capital method to estimate the cost of road traffic crashes in Iran, and the main result is that the cost for the year 2009 is estimated to be around 114,455 billion Iranian Rials (about $US 11.458 billion). The present research shows that road traffic crashes cost Iran more than 1. 41% of its GNP in 2009, and that property damage costs resulting from traffic crashes accounted for around 0.52% of Iran's GNP, with lost out-

put accounting for 0.4%. These are the highest percentage value factors of the various costs incurred by traffic crashes.

Moreover, the costs of different types of traffic casualties (including traffic fatality, traffic serious injury and traffic slight injury) for the year 2009 are estimated. The cost of a traffic fatality in 2009 is estimated at around 613.5 million Iranian Rials (about $US 61.4 thousand), and similarly a serious traffic injury is estimated at 107.3 million Iranian Rials (about $US 10.74 thousand), while the cost of a slight injury is estimated at 18.3 million Iranian Rials (about $US 1.83 thousand).

Moreover, this study estimates the costs of a fatal road crash, a serious-injury road crash, a slight-injury road crash and a property-damage-only crash in Iran for the year 2009, where a fatal road crash cost 903 million Iranian Rials (about $US 90.47 thousand), a serious-injury crash cost 273 million Iranian Rials (about $US 27.4 thousand), a slight-injury crash cost 138 million Iranian Rials (about $US 13.82 thousand), and a property damage only crash cost 112 million Iranian Rials (about $US 11.2 thousand).

It can be seen that while the more severe road crashes caused lost output and the higher cost, the extremely high prevalence of less serious and property damage only crashes means

Table 6. The values of a road crash fatality, a road crash injury and a PDO crash in Iran for the year 2009

		Lost output Cost	Medical Cost	Human Cost	Property Damage Cost	Total Value
A Road Fatality	Millions of Iranian Rials	477.95	39.92	95.59	-	613.46
	Thousands of US Dollars	47.848	3.996	9.570	-	61.414
	Percentage	77.91%	6.51%	15.58%	-	-
A Serious Road Injury	Millions of Iranian Rials	11.05	60.49	35.77	-	107.30
	Thousands of US Dollars	1.106	6.055	3.580	-	10.741
	Percentage	10.29%	56.37%	33.33%	-	-
A Slight Road Injury	Millions of Iranian Rials	4.36	9.73	4.23	-	18.32
	Thousands of US Dollars	0.437	0.974	0.423	-	1.83
	Percentage	23.82%	53.11%	23.08%	-	-
A PDO Road Crash	Millions of Iranian Rials	1.88	-	0.61	59.07	61.55
	Thousands of US Dollars	0.188	-	0.061	5.914	6.162
	Percentage	3.05%	-	0.99%	95.96%	-

Table 7. Estimated costs of road crashes in Iran according to severity level in 2009 (millions of Iranian Rials)

Accident Type	Fatalities		Serious injuries		Slight injuries		Involved vehicles		Total cost (Millions of Iranian Rials)
	Average value	Assumed involved number	Average value	Assumed involved number	Average value	Assumed involved number	Average value	Assumed involved number	
Fatal	613.46	1.17	107.30	0.58	18.32	0.64	61.55	1.82	903.73
Serious injury	-	-	107.30	1.39	18.32	0.68	61.55	1.82	273.63
Slight injury	-	-	-	-	18.32	1.42	61.55	1.82	138.04
PDO	-	-	-	-	-	-	61.55	1.82	112.03

that they account for the largest proportion of the Iran's GNP. Therefore a large effort is re- quired to mitigate the effect of these less seri- ous crashes, which may be neglected due to

Table 8. Traffic crashes cost

| Classification of Traffic Crashes Cost	Cost-component	Estimated Value (Billion Iranian Rials)	Estimated Value (Billion US Dollars)
Property damages	Costs related to property damage	42,191.42	4.224
Casualty-related costs	Human Costs	18,522.29	1.854
	Medical costs	14,419.50	1.444
	Lost output costs	32,296.66	3.233
Administrative costs	Human costs	7,025.33	0.703
Total cost of traffic crashes	-	114,455.19	11.458
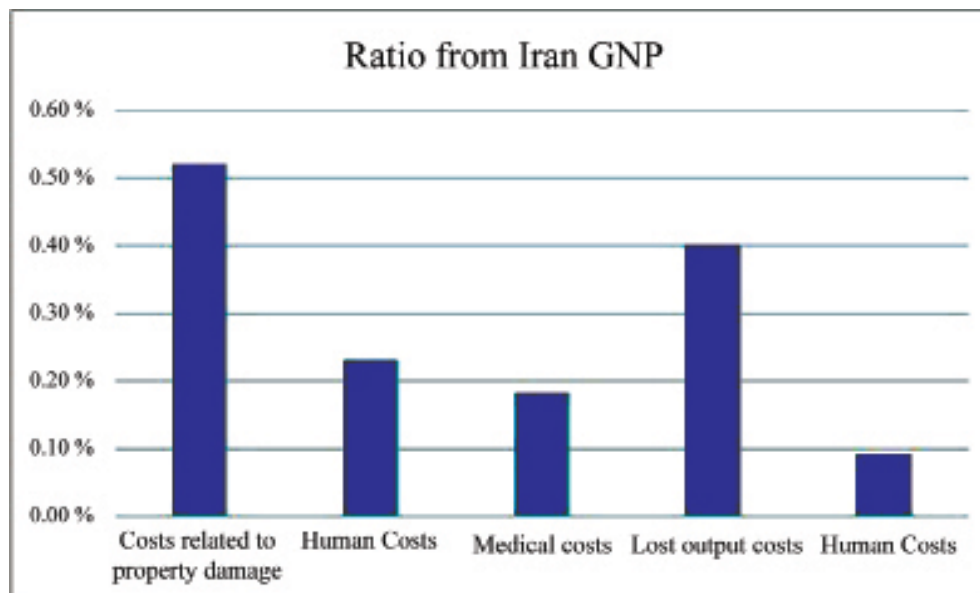
Figure 3. The ratio of each cost-component to the Iran GNP in 2009

their reduced severity compared to fatal and serious injury crashes. Due to the high prevalence of the lost time, output and resources resulted from these smaller crashes is considerably greater than may be expected. It is the fact that they are not being actively reduced due to their status as being low-impact to society. This study has shown that when the effects are combined, they are in fact high impact to society and economic functioning.

At the other end of the scale, fatal and serious injury crashes on a stand-alone basis have a very high financial cost, and other serious associations, in terms of human costs, loss of morale, and a large effect on the individuals involved and wider society as a whole. There are already considerable efforts to reduce the number of these serious crashes, and as a result they are much less prevalent than the less serious injury and property-damage-only crashes; however their extreme severity when they do occur means that efforts must be expanded to reduce their incidence also.

This study has shown the different impacts of various levels of crashes severity, and has highlighted the fact that efforts are required across the board to reduce losses in terms of human costs, finances, time and resources. The HC method has shown itself to be a very useful tool for countries such as Iran, where there is a lack of data available and possibly less understanding of the issues by the wider populace. Further work should focus on better data collection regarding road crashes, to allow more detailed analysis that may help tailor policy and education in order to reduce the prevalence of all severity levels of road crashes.

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