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COSTING ROAD TRAFFIC ACCIDENTS IN ETHIOPIA

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By: MURAD MOHAMMED

A THESIS SUBMITTED TO SCHOOL OF GRADUATE STUDIES OF ADDISABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN CIVIL ENGINEERING

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Abstract

Road accidents have many negative costs that are regarded as socio-economic costs. In recent years, road traffic accidents have caused a significant and increasing socio-economic loss in developing countries in general and in Ethiopia in particular. With the high growth of road accidents throughout the developing world, it is essential that adequate sums of money are spent in dealing with the problem. In the absence of an estimate of accident-related economic issues, it is difficult to identify the sums of money that should be invested each year on road safety countermeasures. Nevertheless, the estimation of the national explicit costs of road accidents as well as the implicit value of the accidents is rarely highlighted to policy makers.

This paper aims to review accident costing methodologies in developing countries and apply it in estimating the economic loss of road traffic accidents in the country, Ethiopia. And also it focuses to insight the challenges of estimating the costs of road accidents in low income countries where vital registration and relevant statistics concerning road accidents are scarce. A feasible method for costing road accidents in such instances is identified, and the severity and costliness of road accidents in the country is demonstrated. Accident data and cost figures of 2009/10 are considered to make the estimation of the annual traffic accident cost in Ethiopia. The analysis shows, among other things, road accidents erode more than 0.49% of the country's Gross Domestic Product (GDP).

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List of Acronyms

ADB	Asian Development Bank
BTRL	British Transport Research Laboratory
CSA	Central Statistical Agency
EMS	Emergency Medical Service
ERA	Ethiopian Roads Authority
ETB	Ethiopian Birr
GDP	Gross Domestic Product
GNP	Gross National Product
IMF	International Monetary Fund
ORN	Oversea Road Note
PGS	Pain, Grief and Suffering
RSDP	Road Sector Development Program
TRL	Transport Research Laboratory
UK	United Kingdom
UNECA	United Nations Economic Commission for Africa
w.r.t.	with respect to

1. Introduction

1.1. General

Road traffic accidents in developing countries tend to be the major cause of fatalities and disabilities. In Ethiopia, the road traffic accident problem is now also regarded as one of the most serious social and public health problems. Annually, there is a significant loss of human and economic resources in the country for which road traffic accident is responsible. This problem is increasing from year to year at an alarming rate accompanying the rapid growth of population and the vehicles fleet (Berhanu, 2000).

According to a report by federal police in the year 2007/08, for instance, there were 1802 traffic accident fatalities, 2156 serious injuries, 2123 slight injuries and 9005 property damage. With the expected considerable underreporting, the road traffic hazard is believed to be much higher than indicated by such statistics. Compared with international figures, the country is one of the worst examples in terms of fatality rate per vehicle which was 94.4 fatality per 10,000 vehicles in 2009/10.

Road traffic accidents are commonly viewed in terms of individual personal losses or as general statistics. Unlike aviation or rail accidents (where frequently, many persons may die in a single accident), the large-scale economic and social impact of road accidents is rarely appreciated, as road accident deaths and casualties normally only happen in ones and twos. Road traffic accident costing attempts to estimate the annual cumulative losses incurred by a country as a result of road accidents.

Moreover most people consider road traffic accidents are unavoidable in road transport systems. However, identifying and determining the significance, magnitude and nature of the problems may only change such attitudes. Road users and people in general , decision makers and politicians in particular, have to acknowledge the road hazard problems in their true proportions: as a public health problem, as an economic problem, as a social problem and as a traffic problem (Berhanu, 2000).

In this respect determining the cost of road traffic accidents and the value of preventing them is very crucial with the following points of view. The first need for accident cost valuations, therefore, is at the level of national resource planning to ensure that road safety is given adequate priority in terms of investment in its improvement. A second need for road accident cost figures is to ensure that the best

use is made of any investment and that the best (and most appropriate) safety improvements are introduced in terms of the benefits they might generate in relation to their cost.

1.2. Statement of the Problem

Developing countries face many challenges and have many resource needs. Road safety tends not to receive due consideration because not all road accidents and casualties are reported to the police and there is usually no other system of estimating road accidents and the corresponding casualties nationwide. There is also a problem with the perception that road accidents are random, unintentional, or predestined; i.e., unavoidable. Road accidents are too often accepted as inevitable negative side effects of motorization. However tragic the personal losses, road accidents are rarely perceived as a serious drain on the economy and this leads to complacency towards road safety issues. This view is totally wrong. Road accidents have been shown to cost annually between 1 percent and 3 percent of GDP in developing countries [1]. These are large sums that few countries, especially developing countries, can afford to lose, year after year.

Over the past periods, till now, traffic accident costs in Ethiopia have been estimated by the police on the loss of property damage and the general economic loss to the country has been estimated as one percentage of the GDP. However, this type of costing road traffic accident significantly underestimates the actual loss. This leads to underestimation of economic effects of road traffic accidents by decision makers and hence gives less priority to road safety issues. There are a number of issues which often arise when road safety strategies are to be proposed to address the road accident situation in the country. For instance, in order to conduct an effective education and campaign program on traffic safety, the estimation of the cost of road traffic accident in the country is essential.

Therefore, estimating the costs of road accidents is important to highlight the total economic loss to the country to raise the recognition of road traffic accident problem in the country. Moreover, it is helpful to decide in assigning national resource and to evaluate investment program on traffic engineering to increase the safety, as important using data as a basis or tool to tackle road accident problems.

1.3. Objective of the Study

The objectives of this study are to review accident costing methodologies which have been applied in various countries in the world and to estimate the costs of road crashes and casualties and assess the annual economic loss of Ethiopia due to traffic accident. This study also attempts to provide rationalized information on the most current and comprehensive road accident costs, based on reliable and available sources.

Specific Objectives

- To develop proper definition for fatality accident, severe injury accident, slight injury accident and property damage accidents.
- To assess accident costing methodologies being used at different countries and selecting the proper one in the context of Ethiopia.
- To estimate costs of road crashes and casualties for each level of severity.
- To estimate the annual economic loss of Ethiopia due to traffic accident.

1.4. Scope of the Study

This study attempts to provide rationalized information on the most current and comprehensive road traffic accident costs, based on reliable and available sources. Information and data on road accident statistics and all associated cost elements in 2009/10 are employed in this study. The study is made based on limited information available from selected stake holders and due to the limitation of budget the data collected for medical and property damage costs is based on hospitals and insurance companies.

1.5. Organization of the Research

This paper work is organized into five main chapters. The chapter hierarchy is aimed at making the paper to have a scientific format. The general sense of each chapter can be summarized as follows.

The first chapter is the introduction part. It starts by discussion in the general influence of road traffic crashes in the socio-economy of Ethiopia and it extends its explanation on the weak attitude and awareness of the society about road safety issues. It also describes the extent of the problem in

Ethiopia to the level it seeks study on the area. The chapter closes its discussion by stating the objectives of the study and how the paper is organized.

The second chapter is the traffic safety situation in Ethiopia. This chapter mainly describes the traffic growth, expansion of road network, accident trends, causes, measures taken. It also summarizes available previous studies conducted in the country on road traffic accident costing.

The third chapter is the literature review part. The discussion of this chapter mainly focuses on the review of similar studies on the subject topic from a wide range of sources of material mainly those studies done in developing countries. It presents the extent road traffic accident being affecting the economy of different developing countries by showing the economical loss in terms of percentage GDP of the countries. Moreover, the chapter explains the available road accident and casualty definitions being practiced in different nations of the world. The chapter gives large coverage for the detail explanation of various road accident costing methodologies that have been utilized in various countries and concludes the discussion by selecting the most appropriate approach to road traffic accident costing in Ethiopia taking into consideration the actual situation therein.

The fourth chapter is the methodology and data collection part. It describes in detail how the selected methodology is adopted to come up with the required cost estimates of different components therein. It elaborates briefly the components within the method. In addition to methodology the chapter also explains about the data required, from where the data obtained, and finally how it is collected and presented here.

The fifth chapter is the analysis and discussion part. In this chapter the collected data are analyzed in detail for each cost components. It computes the estimates of the road accident costs in Ethiopian context and followed by a presentation on cost computation at the national level. It finally discusses the findings of the analysis.

The last chapter is the conclusion and recommendation part. In brief the chapter presents what conclusions can be drawn from this study and what lessons can be gained from the study for different stakeholders who directly or indirectly are affected by road accident. The chapter concludes its discussion and of course the paper by giving possible recommendation on the requirement of further research on the subject matter and a significant focus from decision makers.

2. Road Traffic Accident Situation in Ethiopia

2.1. General

Road transport has been serving the major mode of transport for both domestic and international transport services in Ethiopia. Kifle (1996) [3] indicated that in Ethiopia more than 90 percent of all the inter-urban freight and passenger movements are contributed by the road transport. In this country the motorization level is very low as 17 vehicles per 10,000 populations in 1996/97. Despite having a very low road network density and vehicle ownership level, the country has high accident record. For instance, in the year 2008/9 there was 15,695 reported roads traffic accidents in the country and out of which 2211 were fatal, 2276 were serious injury, 2221 were slight injury, and 8987 were property damage only accidents. As a result of these accidents 2611 deaths, 4177 serious injuries, and 4312 slight injuries have occurred. This is clearly a very high figure in comparison to the vehicle population in the nation.

The traffic accident situation in the country apparently underlines the dangerous road user behavior, the unsafe roads and their environment, and worn-out vehicles on the road network. This circumstance is, probably, not clear and does not seem imperative to politician and society at large. The road accident problem however is a very serious problem which needs sustainable solutions without delay (Berhanu, 2000) [2].

The perception of road accident problem in the country is very much related to the availability of sufficient information. Road accident data analyses and research activities on the road traffic accident problem in Ethiopia are very limited.

2.2. Road Network and Traffic Growth

Ethiopia has been showing a considerable progress in road sector development in recent years through the construction of numerous roads. The Road Sector Development Program (RSDP) the country has put as a strategy can take the major share for this progress. This has brought a significant improvement in the country's road network.

Table 2.1: Growth of the Classified Road Network and Change in Road Density (2000 – 2010)

Year	Road Network (km)				Growth Rate (%)	Road Density /1000 Popn.	Road Density /1000 sq. km
	Asphalt	Gravel	Rural	Total			
2000	3824	12250	15480	31554	-	0.50	28.69
2001	3924	12467	16480	32871	4.2	0.50	29.88
2002	4053	12564	16680	33297	1.3	0.49	30.27
2003	4362	12340	17154	33856	1.7	0.49	30.78
2004	4635	13905	17956	36496	7.8	0.51	33.18
2005	4972	13640	18406	37018	1.4	0.51	33.60
2006	5002	14311	20164	39477	6.6	0.53	35.89
2007	5452	14628	22349	42429	7.5	0.55	38.60
2008	6066	14363	23930	44359	4.5	0.56	40.30
2009	6938	14234	25640	46812	5.5	0.57	42.60
2010	7476	14373	26944	48793	4.1	0.58	44.39

Source: Ethiopian Roads Authority RSDP Report

As Table 2.1 clearly shows on the past ten years the total road network of the country has significantly increased from 31554 km with a road density of 0.50 per thousand people and 28.69 per thousand square km in the year 2000 to 48793 km with a road density of 0.58 km per thousand people and 44.39 km per thousand square km in the year 2010. The average annual growth rate is about 4.5%.

On the other hand the country has been showing a considerable increase in traffic volume as a result of the economic development registered with an average annual GDP growth of 6.5% for the past ten to fifteen years [21].

Table 2.2: Cumulative number of Registered Vehicles by Type and Size

Type of Vehicle	Up to 2006/07	Up to 2007/08	Up to 2008/09	Up to 2009/10	Growth (%)
Cars up to 5 seats	127055	134826	136445	138093	1.09
Cars 6-12 seats	37987	40447	41414	42454	1.12
Medium Bus 13-29 seats	8582	9085	9193	9382	1.09
Bus > 29 seats	3735	3899	3976	4095	1.10
Truck up to 70 quintals	35868	38494	39643	40369	1.13
Truck 71-180 quintals	22538	23930	24371	24929	1.11
Trailer + Semi-trailer	4032	4195	4239	4327	1.07
Others	13120	13126	13137	13145	1.01
Total	**252917**	**268002**	**272418**	**276794**	**1.09**

Source: Unpublished report of Road Transport Authority, 2009/10.

As clearly shown in Table 2.2 the total number of vehicles experienced significant increase, which is about 9% growth, from 2007/08 to 2009/10.

2.3.Current Accident Situation

Based on the most recent data available a summary of road traffic accidents in Ethiopia is given in table 2.3 below. Every month, around 570 people are killed or hospitalized by road accidents. Road accidents and casualties are continuing to rise; fatal road accidents and fatalities, which have decreased slightly (1.85%), since 2006/07.

Table 2.3: Comparison of No. of accidents and casualties for different severity in 2008/09

Accident Type	Number of Accidents	Number of Casualties	Casualty/Accident Ratio
Fatal	2211	2613	1.18
Serious	2276	4177	1.84
Slight	2221	4312	1.94
Damage Only	8987	-	-

2.4. Under-Reporting

Relatively few injuries are reported for every fatality. As stated in Study Report for a Sectoral Road Safety Programme in Ethiopia in 2001[20], Road accident reporting levels are less than 2 serious injuries for every fatality and less than 1.5 slight injuries for every serious injury. It is known fact that all road traffic accidents including damage only accidents are required to be reported. Yet the police readily acknowledge that not all accidents or casualties are reported to them and their statistics underestimate the true extent of the road accident situation.

Not all road accidents are perceived as crimes and many road users will prefer to settle claims immediately and not involve the police. It is likely that road accident fatalities are between 20-30 percent higher as some fatalities will not be reported and others seriously injured may die without the police being informed of the change in casualty status on the other hand injuries can be assumed to average more than 10 times that of fatalities so it is likely that the actual injury toll is over twice that is being reported [20].

Even though the extent varies under-reporting is a common problem to most countries except those few where the hospital reporting systems are integrated with the police or where approval is required before vehicle damage can be repaired.

2.5. Accident/Casualty Rates

Accident/Casualty Rates is defined as the ratio of accident/casualty and some measurement or estimate of the exposure (the existence of the units and or the magnitude of the activity behind the measurement). Two principal dimensions can be viewed in this definition i.e. the exposure and the accident event classified with respect to accident consequences. Changes in any of these dimensions could mean a change in the entire safety situation (Berhanu 2000).

To observe the risk level of road traffic accidents and the motorization in the country the following mathematical definitions of different types of risk and motorization are of great importance [2]. In general risk is defined as:

$$Risk = \frac{accident\ events\ (classified\ w.r.t.\ consequences)}{exposure} \qquad (2.1)$$

When traffic accidents are used in line with diseases for comparison, it is a health risk and population is used as a measure of exposure:

$$Health\ Risk = \frac{fatalities}{population} \qquad (2.2)$$

On the other hand when traffic accidents are used for comparison of traffic safety among countries, it is a traffic system risk and number of motor vehicles is used as a measure of exposure:

$$Traffic\ System\ Risk = \frac{fatalities}{motor\ vehicles} \qquad (2.3)$$

The motorization of a country can be defined as:

$$Motorization = \frac{motor\ vehicles}{population} \qquad (2.4)$$

When we analyze the current traffic accident risk of Ethiopia with respect to the above definition, in the year 2009/10 fatalities per 100,000 populations is estimated to be 3.32 and fatalities per 10, 000 motor vehicles is estimated to be 94.4. Moreover, the motorization per 100, 000 population of the country in 2009/10 is estimated as 351 motor vehicles. From the above analysis and other similar documents the fatality risk observed in Ethiopia has not shown any significant improvement because it remains almost on 3 for the past 10 years. On the other hand the country's traffic system risk is showing declining from 236 in 1989 to 198 in 1994 and to 94.4 in 2010. This justifies that there is a significant increase in motor vehicles growth as compared to fatal traffic casualties. This can also be proved by the change in motorization observed in the country from 12 in 1989 to 16 in 1994 and to 351 in 2010.

However, Study report by Silcock, R. (2001) indicated that Ethiopia has the best record from most African countries in terms of personal safety but the worst record when traffic safety is concerned. The report also added that due to the lesser value of personal safety risk road safety is not a priority for the Ethiopian Ministry of Health.

2.6. Road Accident Trend in Ethiopia

As shown in table 2.4, all accident severities are increasing year to year. Damage only accidents have shown the largest increase of all other groups.

Table 2.4: Road Traffic Accident Trend in Ethiopia (2001 – 2005)

Year	**2001/02**	**2002/03**	**2003/04**	**2004/05**	**2001-05 increase (%)**	**Annual Avg. Increase (%)**
Fatal	1327	1510	1630	1801	36	12
Serious	1712	1790	2072	2368	38	13
Slight	2196	2365	2705	2731	24.4	8
Damage Only	7188	8563	10569	10822	51	17

Source: Federal Police Commission

2.7. Road Accident Characteristics

Single vehicle road accidents dominate the accident situation in Ethiopia with over two-thirds of all injury accidents involving pedestrians. Vehicles overturning accounted for the next largest share (14%) while passengers falling from vehicles represent 5% of all road accidents in the period 2001-2005.

Table 2.5: Road Accident Severity by Accident Type (2001-2005)

Accident Type	Fatal (%)	Serious (%)	Slight (%)	Damage Only (%)	Total (%)
Pedestrian	63.2	67.5	73.1	0.0	51.0
Overturning	18.0	14.1	11.8	11.5	13.9
Fall from vehicle	8.6	7.0	4.3	0.0	5.0
Head-on	2.9	2.7	1.9	5.2	3.2
Rear-end	1.9	2.3	1.9	23.0	7.0
Right-angle	1.5	2.4	2.5	23.0	7.4
Sideswipe	0.9	0.9	1.2	24.7	6.9
Other	3.0	3.1	3.3	15.6	6.3

Source: Federal Police Commission

2.8. Motor Vehicle Involvement

Table 2.6 shows types of vehicles which are thought responsible for the accident for the periods 2001 – 2005. Trucks accounted for the majority of fatal accidents i.e. 50 %, buses only 14% and cars are responsible for 15% of all fatal accidents. However, Station Wagon and Taxis have a major share in overall traffic accidents during these periods.

Table 2.6: Motor Vehicle Involvement in Road Accidents (2001-2005)

Accident Severity	Car	Station Wagon	Pick -up	Truck 11-40 qt	Truck 41-100 qt	Truck with Trailer	Taxi	Bus	Others
Fatal	288	430	703	1199	1278	362	737	703	628
Serious	700	690	1091	1267	993	282	1451	880	588
Slight	185	1022	1148	1099	883	160	2163	805	649
Damage Only	7662	14596	3764	4258	3385	1495	7148	3028	982
Total	**8835**	**16738**	**6706**	**7823**	**6539**	**2299**	**11499**	**5416**	**2847**

Source: Master's Thesis By Getu Segni (2007)

2.9. Major Causes of Road Traffic Accidents

Traffic Violations were cited in all road accident reports and the major causes of road traffic accidents are shown in Table 2.7 below. Speeding and failure to give way for pedestrian accounted for 40% of all fatal accidents. On the other hand the seven causes mentioned in the table contribute for 74% of the total traffic accidents in 2004/05.

Table 2.7: Major Causes of Road Traffic Accidents 2004/05)

Reasons	**Fatal**	**Serious**	**Slight**	**Damage Only**	**Total**
Failure to give way for pedestrian	313	952	1382	68	2605
Speeding	413	223	342	983	1961
Improper Overtaking	47	69	78	1280	1472
Following too close	42	47	81	2435	2605
Failure to give way for vehicle	37	111	120	1231	1499
Improper turning	35	75	64	1706	1880
Failure to respect right hand rule	89	119	124	693	1025
Others	825	772	540	2426	4563
Total	**1801**	**2368**	**2731**	**10822**	**17722**

Source: Federal Police Commission

2.10. Critical Problems/Reasons

The Interim National Road Safety Coordination Office [21] has listed, in its report, the reasons for high number of road traffic accidents in the country as:

- Lack of driving skills
- Poor knowledge of traffic rules and regulations
- Violation of speed limit
- Insufficient enforcement
- Lack of vehicle maintenance
- Animal drawn carts and animals frequently used main highways
- Lack of safety conscious design and planning of road network
- Disrespect of traffic rules and regulations

- Lack of general safety awareness by pedestrians
- Lack of medical facility in general, in relation to accident severity

These all problems lead to one critical question which asks do road safety issues have got proper attention by the government and the concerned officials. The reason might be lack of such studies which show the economic burden of road traffic accident in monetary terms. Hopefully costing road traffic accidents in Ethiopia can fill this gap.

2.11. Measures taken

The government has started to give some focus, though not sufficient, on road safety in the country since 2000, hopefully the PhD dissertation work of Girma Berhanu on Effects of Road and Traffic Factors on Road Safety in Ethiopia in 2000 has some effect when we look at the time period, by hiring foreign consultants for revising the existing road transport regulations and for preparing study report on Sectoral Road Safety Programe. Since then the government has understood the main reasons for road safety problem in Ethiopia and has suggested the 3E policy as counter measures i.e. Education, Engineering and Enforcement. However, still road safety issues do not get the proper focus from the government.

2.12. Under-reporting of Road Casualties

A study by TRL, Ross Silcock Partner (2001) estimated that the true number of fatalities to be 20-30 percent greater and the total number of road casualties to be twice or more than being currently reported in police statistics. It stated that this estimate should be considered conservative as such levels of under-reporting are found in many countries, with significant under-reporting of injuries in motorized countries including the UK.

It also added that under-reporting of road casualties in Ethiopia is also widely acknowledged by both police and medical professionals. The study further puts three reasons for arguing that the human casualty toll from road accidents is much greater than officially reported by the police; these include severity ratios, hospital data and reporting procedure.

2.13. Previous Road Traffic Accident Cost Estimates

i. Method Used

A study conducted by TRL, Ross Silcock (2001) on road traffic accident costs in Ethiopia has used the Gross Output method by forwarding some justifications.

After briefly discussing the different approaches available to cost road accidents it generalized that employing the different methods described produce very large differences in costs which were shown in developed countries to range from about $400 to over $30 million. Referring the opinion of the specialists in the field the study concentrated on only two methods that are thought to be applicable in conventional cost-benefit analysis and they are the Gross Output approach and the Willingness-to-Pay approach.

The study further commented on the Willingness to Pay approach by stating that using this method is extremely complex and it can give considerable variation in estimates obtained and causes problems when attempting to cost non-fatal accidents. The study also criticized the method in that only adults can answer the complex questions posed on the questionnaires yet in African countries children form a significant proportion of those killed or injured.

ii. How Costs Estimated

Though the study explains in detail how the Gross Output method is employed in Ethiopia in road traffic accident costs, it has made only broad and very crude estimates of that period's costs by using different ways:

- By making use of an earlier study of accident costs undertaken in Ethiopia

Based on the previous study undertaken by British and American consultants in 1983, this study has tried to arrive at a crude estimate of road traffic costs. This study stated that the previous study used the percentage of resource costs proposed by UK in 1980 to reflect pain, grief, and suffering (PGS) i.e. 30% for fatal, 30% for serious and 10% for slight injury accidents and accordingly the cost was estimated to be 12.5, 5.2, 5.9, and 8.0 million ETB for fatal, serious, slight, and damage-only accidents respectively. And the total cost would become 31.6 million ETB.

However, the study conducted in 2001 has considered two adjustments to the 1983 estimate of accident costs that is to account under-reporting of road accidents and to increase the percentage of resource costs added to reflect pain, grief, and suffering. Accordingly the study suggested to use values recommended in TRL Report ORN10 for PGS but increased slightly i.e. 50% for fatal, 120% for serious, and 15% for slight injury accidents; on the other hand for under-reporting it suggested 25% for fatal, to increase serious and slight injuries to give realistic ratios of fatal to injury accidents of about 1:8, and to use a ratio of 5:1 as a ratio of damage only to injury accidents. As a result the adjusted cost was estimated to be 18.2, 21.2, 14.9, and 32.4 million ETB for fatal, serious, slight, and damage-only accidents respectively. And the total adjusted cost would become 86.7 million ETB for the year 1983.

Then the study further increased the 1983 values by 6% per annum considering inflation, average increase in wages or real changes GNP/capita and arrived at the value of 270 million ETB by 1999. Finally the study further adjusted this value to account the growth in accidents (i.e. 35% for fatal, 65% for serious and 118% for slight) and it was found to be 350 million ETB.

- By using information from current studies which provide estimates of accident costs based on percentages of national GNP per annum.

The study stated that an early study of accident costs undertaken by TRL found that road accidents appeared to cost about 1% of national GNP per annum in most countries for which data were available. The study further indicated that accident costs in East European countries range from 1 to 3 % of GNP as studied by Blomberg of the World Bank and a regression equation was derived which suggests that for countries with very low levels of GNP/capita such as Ethiopia, accident costs would be in the range of 0.8 to 0.9 percent of GNP.

Thus the study has estimated the costs of road traffic accidents in that period to be in the range of 384 to 430 million ETB using 0.8 to 0.9 % GNP.

- By using ratios of accident costs by severity (i.e. fatal, serious, slight and damage-only) from various countries.

In this technique, the study has used the basic information on the cost of damage only accidents to estimate the broad cost of slight, serious and fatal accidents by applying cost ratios derived from other studies. The study particularly concentrated on cost ratios determined in the 1983 study of road accident costs in Ethiopia which is 10:3:2:1 as ratios of damage only to slight to serious to fatal accidents. The study has also used the data obtained from police statistics for road accidents and from insurance company on average cost of claim and restructured this claim value into cost values for fatal, serious, slight and damage only accidents using the above ratios. The costs are further adjusted to reflect pain, grief and suffering, and to account for under-reporting. Accordingly it has arrived at an estimated cost of 390 million ETB.

3. Review of Literatures on Costing Road Traffic Accidents

This chapter presents the review of similar studies on the subject topic from a wide range of sources of material mainly those studies done in developing countries. The research results and experience gained from these studies are not directly adapted; rather there are important conclusions to be drawn from the findings which are relevant to Ethiopia [2].

The main objectives of the literature review are:

i. To assess the available methodologies on costing road traffic accidents to the level of knowledge that exists today among researchers worldwide.

ii. To strengthen the problem of the study defined earlier by referring to findings of similar studies showing that road safety issues do not get sufficient attention by decision makers and determining the economic loss of road traffic accidents in the country may help the concerned bodies to give more focus towards it.

iii. To assist in selecting the most appropriate methods to be used for this study.

3.1. General

Road traffic crashes result in economic, social and human costs, which place a severe financial strain on many countries. Globally road accidents in low-income countries and emerging nations cost at least $100 billion a year (Hyder, 2002) [4]. Fatality rates (per licensed vehicle) are high in comparison with those in developed countries. According to The British Transport Research Laboratory (BTRL) Report (1995) [5]; the low-income countries have 85% of the world's road accident fatalities despite having relatively few vehicles; and this costs approximately 1.5% of their GNP. In a research conducted in Lesotho, road accidents erode more than 1.85% of the country's gross domestic product (GDP) [6]. A research conducted in Vietnam shows that road traffic accident is responsible for the loss of 0.45% of the country's GDP in the year 2004 [7]. The total national economic loss resulting from road accidents is estimated to be 2.13% of the GDP of Thailand in 2002 [8]. In Singapore, road traffic accidents accounts for the loss of 0.3% of GDP of the country in 2006 [9]. As clearly stated in ADB-ASEAN Road Safety program Accident Costing Report, in the year 2003 Brunnei Daruselam has drained 1.02% of the nation's GDP due to road traffic accidents [10]. The above data from different literatures clearly indicates

that road traffic crashes have been resulting a severe financial and social strain on many countries.

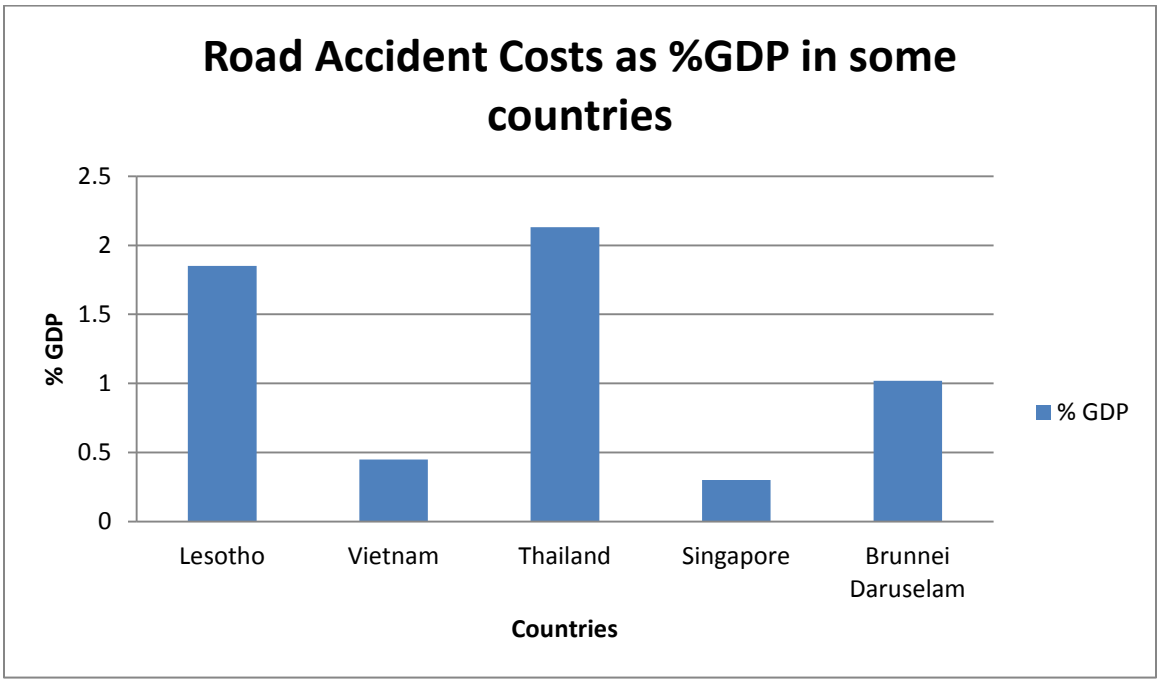


Fig 3.1: Comparison of Accident costs of some developing countries

To fight against this problem, road safety is becoming one of the issues demanding funding and other resources like creating awareness on the magnitude of the problem and mobilizing human & economic resources to improve the safety of the road transport in these countries.

In order to assist decision making process in allocating funds for road safety, it is essential to determine the cost of road accidents and the value of preventing them. So, the first need for cost figures is at the level of national resource planning to ensure that road safety is ranked equitably in terms of investment in its improvement. The second need for road accident cost figures is to ensure that the best use is made of any investment and that the most appropriate safety improvements are introduced in terms of the benefits that they will generate in relation to the cost of their implementation.

As it is discussed above, the application of cost-benefit analysis for proper allocation of resources to road safety strictly requires costs of accidents and values of accident prevention. For example, in high income countries, it is required that an appraisal of new road schemes and

policies includes the estimation of the costs of road accidents (Pierson, Skinner & Vickerman, 1998) [11].

Traffic accident costing basically depends on the magnitude of the severity of the accidents considered for costing. Generally any traffic accident involves either injury to a person i.e. personal injury accident (together with vehicle or property damage) or involves only damage to vehicles and possibly property i.e. damage only accident. According to the Ethiopian transport regulation [2], a driver of a vehicle involved in a road accident shall notify the nearest police station immediately if the accident involves personal injury and within twenty-four hours if it involves property damage only. After which the traffic police will come to the scene and investigate the situation and classifies as being fatal, serious or slight. According to the regulation all accidents are reportable.

3.2. Accident Classification

Estimation of road traffic accidents basically demands road accident statistics as a main input. As stated in the objective part of this paper one of the aim of this research is to develop proper accident definition by reviewing the most common practices internationally. In this regard assessing the definition of different category of road accident being used in different countries is very essential.

Various countries have got their own definition to treat a certain accident as road traffic accident. In Belgium, these are accidents occurred on a public road, which are reported to the police and which lead to casualties where as accidents involving material damage only have not been included in the accident statistics since 1973. In Canada, it is a traffic collision which occurs on a public roadway that involves at least one motorized vehicle and results in death or injury to at least one involved person, or property damage exceeding a specified monetary amount. In Germany, it is defined as an accident occurring on public roads or squares involving at least one moving vehicle and resulting in human injury or death and/or in material damage on the condition that material damage only are registered if the cause of accident is an offence such as driving while under the influence of alcohol. An accident is said to be road accident, in Britain, if it occurs on a public road and if it involves at least one vehicle and resulting in human injury or death whereas damage-only accidents are not compiled. Road accident has been defined in

United States as an event that produces injury and/or damage, involves a motor vehicle in transport, and occurs on a traffic way or while the vehicle is still in motion after running off the traffic way [12].

Based on the severity level a certain road traffic accident creates, road accidents are almost everywhere categorized as fatal, serious, slight or damage only. It should be noted that accident severity is defined by the most serious casualty class of any of the victims of the incident. The `cost of an accident' is therefore not the same as the `cost of casualties' resulting from that accident, at a more disaggregated level. Failure to distinguish this difference when examining the benefits of different detailed remedial measures can result in different project cost-benefit rankings.

Most countries in the world use nearly similar definition on different level of accident severities. The standard definition of a fatal accident, as is used by UN, is an accident as a result of which any person was killed outright or died within 30 days. On the other hand a serious injury accident is the one a person is admitted to hospital as a result of injuries from a road crash (Australia). An accident making the victim suffers non-fatal injuries that result in hospitalization, including for observation only, for a period of at least 24 hours is serious injury accident (Canada). UN defines a serious injury accident as an accident that creates fractures, concussion, internal lesions, crushing, severe cuts, laceration, or severe shock requiring medical treatment and any other serious lesion entailing hospitalization [12].

Most European countries define different accident severity level as follows (TRL, 1995) [5]:

An accident is said to be ***fatal accident*** if one or more victims die within 30 days of occurrence of the accident.

On the other hand an accident is termed as a ***Serious Injury Accident*** if one or more victims are seriously injured as a consequence of the accident but there are no deaths.

A ***serious injury*** is defined in the UK as either one for which a person is retained in hospital as an "in patient", or if any one of the following injuries are sustained whether or not he or she is held in hospital:- fractures, concussion, internal injuries, crushing, severe cuts and lacerations, or severe general shock requiring medical treatment.

A ***Slight Injury Accident*** is an accident as a consequence of which there are no deaths or serious injuries but the victim is slightly injured (outpatient).
A ***slight injury*** is an injury of a minor character such as a cut, sprain or bruise.

Damage-only accident is one in which no one is injured but damage to vehicles and or property is sustained.

3.2.1. Current Accident Severity Definition in Ethiopia

In Ethiopia, even though a documented definition of different accident severity levels was not obtained for this study, the information obtained from the interview of some police officers shows that:

A **fatal accident** is the one in which one or more individuals die as a result of traffic accident within the same reporting year of the occurrence of the accident. This definition is somehow different from the standard definition of UN which limits within 30 days.

A **serious injury** is one in which a victim sustains severe cuts, bleeding, breaks, and other damages which requires him a medical treatment as "in-patient" in hospital.

A **slight injury** is the one as a result of which the victim sustains only small cuts, scratches, and other small damages which may be treated as an out-patient without requiring admission to a hospital.

Damage only accident is the one as a result of which no person is injured only one or more vehicles involved in the accident are damaged.

Having understood benefits of costing road accidents and defining the different severity levels of accidents it is possible now to assess the various approaches available to cost road traffic accidents.

3.3. Available Approaches

According to the study by Hills and Jones-Lee (1982 and 1983) [13] six different methods of road costing have been proposed for developing countries. They stated that the criteria for

choosing any appropriate method at any particular situation depends on the objectives and priorities of those who intend to use the costs and values concerned.

The six accident costing methods as briefly stated by Hills & Jones – Lee are mentioned hereunder: Below are the details of each method of road accident costing [13]:

A) The Gross Output Method

This method basically requires the estimation of direct and indirect costs incurred to individuals and society as a whole. Generally the costs of a traffic accident are divided into two main categories: (i) the costs due to the loss of current resources, including the costs of vehicle damage, medical treatment, and administrative costs, and (ii) the costs due to the loss of future resources that the victim would have lived to earn which must be discounted back, to give present values (Jacobs 1995) [14].
Usually a significant sum is added to reflect the "pain, grief, and suffering" of the accident victim and to those who care for him or her.

It is to be noted that most of the road traffic accident costing conducted in developing countries have utilized this approach. Zewotir and Maqutu (2001) have indicated that although it is not the most theoretically appropriate method, for practical purpose, they have used the popular gross output approach to road accident costing in Lesotho [6]. Melhuish, Ross, Goodge, and Tanaboriboon (2003) have also indicated in their research, citing the references therein, that the gross output method is one of the most widely used method to estimate accident costs in developing countries [8].

Moreover, TRL Ross Silcock (2001) has proposed this method for costing road accidents in Ethiopia after justifying the limitations of using other methods in regard to the situation of the country and the practice of most developing countries.

However, this method suffers a drawback when estimating lost output using the average wage rates of the nation due to the majority of the accidents concentrate around cities and on people

living in cities where wage rates are significantly above the national average. But the method still can be used with some modification to account for this limitation.

B) The "net output" approach

Unlike the gross output approach the discounted value of the victim's future consumption is subtracted from the gross output figure. In this approach the difference between an individual's gross output and future consumption may be regarded as a measure of the rest of society's economic interest in his continued survival.

The major limitation in using this approach is that it could be very difficult to estimate what a person consumes through his/her life time. The second limitation is lack of literatures used this technique in estimating road accident costs and it is not being used in most countries.

C) The "life-insurance" approach

According to this method the cost of road accident is directly related to the sums which individuals are willing or are able to insure their lives. This is based on the assumption that insurance cover provides an estimate of the value of his/her life to dependants.

To base any analysis on the insured population alone is almost certainly to choose a biased sample. This approach is of particularly limited value in countries like Ethiopia where relatively few people carry life insurance. The second limitation in using this approach is that it says nothing about the value that individuals place on their own lives.

D) The "court award" approach

The sums awarded by the courts to the surviving dependants of those killed or injured are treated as indicative of the cost that society associates with the road accident or the value that it would have placed on its prevention. Real resource costs are then added to this figure to obtain the cost of an accident.

The main drawback of this method in using for estimating road accident costs in Ethiopia is that the sums awarded by the court is highly dependent on the complex issues taken that are to be taken into consideration such as degree of negligence of the defendant, whether any blame is

attached to the person killed or injured, and whether industrial injury benefits are to be paid rather than the real costs incurred due to the occurrence of the accident [20].

E) The "implicit public sector valuation" approach

With this method an attempt is made to determine the costs and values that are implicitly placed on accident prevention in safety legislation or in public sector decisions taken either in favor of or against investment programmes that affect safety.

As clearly stated in some studies the main drawback of using this method is that there is an enormous variation in 'implied values of life", even within the same sector.

F) The "willingness to pay" Approach

This method mainly estimates the amount of money people affected would pay to avoid an accident. Each individual has their chance of being involved in a fatal accident reduced by a small margin if a road safety improvement is introduced. Thus the value of preventing one fatality in one accident is defined as the aggregate amount that all the affected individuals in society are willing to pay for these small risk reductions.

Estimation of willingness-to-pay costs and values is far from straight forward. Various methods have been used and include an approach where estimates are obtained by observing situations where people actually do trade off wealth or income for physical risk. Another approach uses a complex questionnaire where samples of individuals are asked more or less directly how much money they would be willing to pay in order to obtain a small reduction in their own or other people's risk.

In choosing the appropriate methodology for costing road traffic accidents in developing countries like Ethiopia there are a number of issues that should be taken into account like the objectives and priorities of decision makers who actually uses the cost figure for implementation of policies. For instance if the objective is to maximize social welfare this can at best be achieved through utilizing the willingness-to-pay approach. Whereas if the objective is to enhance the Gross National Product (GNP) gross output approach is better to adopt [7]. These two different

methodologies follow quiet different approaches. While using gross output methods costs are estimated based on historical data of costs incurred following an accident. Unlike the gross output method the willingness-to-pay approach however attempts to estimate the true costs by considering what one would do to avoid being involved in accident [7].

Most of developing countries have used the Gross Output approach in estimating their costs of road traffic accidents. In Vietnam [7], for instance, this approach is chosen owing to the difficulty of applying willingness-to-pay approach as it is based on complex questionnaires asking about perceived risk and payment for the avoidance of hypothetical risk where as the gross output approach is more reliable, internally consistent and has a strong theoretical base.

Actually of all the available methods mentioned before the Gross Output (Human Capital) Method is the most widely known as it is very well documented in the *Guidelines for Estimating the Cost of Road Crashes in Developing Countries* (Babtie Ross & Silcock 2003) [15]. Thus, this method will be employed to estimate accident costs in this study.

3.4. Parameters Considered

In employing the gross output approach most developing countries consider five cost components to determine economic losses of road traffic crashes. In fact the accident statistics is the first parameter to have at hand when working on such studies. In Thailand, for instance, five cost parameters have been used to come up with the overall accident costs namely hospital and medical cost, output lost, property damage cost, administrative costs (insurance and emergency medical service cost) and human cost [8].

i. The *hospital and medical costs*

The hospital and medical costs are one of the important cost parameters required in estimating economic loss of road traffic accidents. Melhuish C. et al (2003) has indicated that this cost component arises from in-hospital patient services (costs of operations, x-rays, medicines, doctors' visits, food and bed); outpatient services; rehabilitation costs; prosthetic costs and funeral costs. Trinh, T.A. et al (2005) has also described this cost as the cost of at-scene care, transport, in-hospital stay, outpatient treatment, drugs and prosthetics. Zewotir,T. et al (2001)

used cost of inpatient treatment (i.e. costs of staff, meals and bed), overhead costs (medicines, doctors visits), cost of operation, and cost of outpatient treatment as the costs of medical and hospital treatment. Still more literature can be sited showing the inputs used to arrive at this cost component however the above mentioned literatures can give sufficient indicative in arriving at this component in this study.

ii. *The lost output cost*

Lost output is the loss of productivity of those affected by road traffic accidents. Melhuish C. et al (2003), Zewotir,T. et al (2001), and TRL (1995) have derived this cost from the average wage of the casualties and care givers, and the amount of time lost due to road accidents. Melhuish C. et al (2003) have acquired the required data from the national statistical office, bank, hospital, and traffic police records. They stated that obtaining wage rates of individuals affected by road traffic accidents is usually difficult in developing countries where there is no well established database system. In this case the annual per capital income of the nation could fairly replace the wage rates and they have used this in their studies.

iii. *The property damage cost*

The *property damage cost* is obtained from the cost of vehicle damage and the cost of public road side facility damage. Due to the limited amount of information available from other sources, Melhuish C. et al (2003) have used the vehicle damage costs obtained from traffic police records only and road side facility damage costs are acquired from highway departments. On the other hand Zewotir,T. et al (2001) have used the data obtained from national insurance company to arrive at this component. Trinh, T.A. et al (2005) have acquired data from the country's major insurance company to estimate this cost component and they indicated that it is difficult to assign different property damage costs for the different severity classes of accidents for the reason that such data categories could not be obtained from any possible sources so that the aggregate cost is used. TRL (1995) indicated that data for vehicle repair costs can be obtained from the following three sources; insurance companies, garages, and fleet operators. The best source to use will depend on the local circumstances.

iv. *The administrative costs*

The *administrative costs* are originated from those costs associated with the processing and handling insurance claims and those costs associated with emergency medical services which include the labor cost, material cost, capital cost and overhead cost. The study conducted in Vietnam considered traffic police service cost, emergency response service cost, and cost of insurance and court administration as administrative costs of road accidents using the data obtained from the police office, courts and insurance company [7]. On the other hand the study conducted in Thailand have used insurance administrative costs and EMS costs as administrative costs of road accidents using the data from previous studies on this particular cost components [8]. The study conducted in Ethiopia proposed that ratios of administrative costs from other countries can be used and as likely to be of the order of 0.2% of all other resource costs for fatal accidents to 14% in the case of slight accidents [20].

v. *The human cost*

And the last cost component is the *human cost*, which accounts for pain, grief and suffering of the casualties being an accident victim, of families and friends. This cost component is proposed by a study conducted in Ethiopia to be a certain proportion of the resource costs of road accidents i.e. 50% for fatal, 120% for serious, and 15% for slight injury accidents [20]. The study conducted in Brunei Darussalam have used the value proposed by TRL, ORN 10 as the cost of pain, grief, and suffering i.e. 38% for fatal, 100% for serious, and 8% for slight injury accidents [10]. On the other hand this cost component is used as 28% of resource costs for a fatality accident and 50% of resource costs for an injury accident by the study conducted in Vietnam and it indicated that using such percentages for this cost component is widely acceptable by Asian Development Bank [7].

4. Methodology and Data Collection

As discussed in the literature review part, about six practical techniques or methods are available to determine the costs of road traffic accidents. However, no single costing method is believed to be an ideal method to use, and a considerable amount of data still needs to be collected regardless of the method used. (Jacobs 1995) [14].

Moreover, in the literature review part it has been tried to show the pros and cons of using the different techniques mentioned there with respect to Ethiopia context and finally the Gross Output method is found to be more appropriate to use for costing road traffic accidents in Ethiopia. Thus, this method is employed to estimate accident costs in this study.

4.1. Gross Output method in practice

This method basically requires the estimation of direct and indirect costs incurred to individuals and society as a whole. Generally the costs of a traffic accident are divided into two main categories: (i) the costs due to the loss of current resources, including the costs of vehicle damage, medical treatment, and administrative costs, and (ii) the costs due to the loss of future resources that the victim would have lived to earn which must be discounted back, to give present values (Jacobs 1995) [14]. Usually, a significant sum is added to reflect the "pain, grief, and suffering" of the accident victim and to those who care for.

These cost components can also be classified as casualty related costs (lost output, medical costs, and pain, grief, and suffering), and accident related costs (property damage and administration). The cost of an accident is therefore the sum of the casualty related costs, plus the accident related costs while the total cost of accidents in the country is the number of accidents by severity multiplied by their respective accident costs.

4.1.1. Cost Components

The detail of the various cost components can be explained one by one as follows.

4.1.1.1. Lost output cost

Road accidents lead to a loss of output on the victim and family members caring for it in the year in which the accident occurs and, in the case of fatal and very serious accidents, on the victim in future years also. In the case of a fatality, the loss of a person's output is of course complete. In this situation, costs in future years have to be discounted to give present day values. The discount rate used should be that which is currently in use by economists and planners in the country concerned. In order to determine "lost output", certain assumptions have to be made. In the case of fatal accidents the number of "person years lost", is obtained by obtaining the average age of accident fatalities and subtracting from the average age at which a person ceases to work. In the case of serious accidents, estimates must be obtained of the average number of days that the injured person spends in hospital and then spends recovering at home from the accident. In the case of a slight accident, an estimate must be obtained of the (relatively small) number of days that the person is not working due to attending a doctor's surgery, a clinic or hospital (as an outpatient) to receive treatment for their minor injury, or being at home for convalescing. Information on days lost following serious and slight road accidents can be obtained from hospital records and from interview with the hospital workers. Loss of output due to permanent and long term injuries depends on the number of cases, the length of absence from work and the percentage disability when work is resumed.

Having derived an estimate (and it should be stressed that it can be no more than an estimate) of the average number of days and years lost following a road accident, the value of those days and years lost must be determined. This is obtained by using figures published by government of national wage rates, before the removal of taxes.

In many developing countries, a significant proportion of the population will be agricultural workers, many being self-employed and probably cultivating small plots of land. For these and possibly other workers (e.g. on short term employment), it is unlikely that published statistics of wage rates exist and estimates will have to be derived of annual incomes per capita.

It is important to note that it is accidents by degree of severity that are being valued but that lost output is obtained on a 'a person-injured' basis. The average number of persons injured per type of accident taking place must then be obtained.

4.1.2. Medical Treatment Cost

The medical costs resulting from road accidents arise from hospital treatment (in-patient and out-patient), treatment by general practitioners and the use of ambulances. The total costs will be determined, apart from the number of casualties, by:

- The average length of stay in hospital
- The average cost per day of hospital treatment
- The average number of out-patient visits
- The average cost per out-patient visit
- The average costs incurred by doctors and nurses
- The costs incurred by ambulance service
- The costs of medicine

All these factors have to be taken into consideration in the case of serious injuries; out-patient and practitioners treatment can be ignored in the case of fatalities, and by definition in-patient costs cannot arise in the case of slight injuries. Some of this information may be available from sources published (usually) by the Ministry of Health. It is unlikely however that annual report will state categorically the average cost per day of hospital treatment.

Efforts should be made to collect information on cost of treatment from hospitals. As stated before, information must be obtained on a 'per-accident' basis and average costs of treatment for persons killed, seriously or slightly injured must be multiplied by the average number of persons injured in the equivalent categories of accident to provide a cost of medical treatment per accident.

4.1.3. Cost of Damage to Vehicles

There are three basic sources of information on cost of damage to vehicles; the insurance companies, garages and large fleet operators such as bus companies and freight operators. The best method to use depends on local circumstances.

If the majority of cars carry comprehensive insurance in a country (as opposed to third party only) and if the cooperation of insurance companies is available, then making use of information held by insurance companies may be the best approach. A specially designed questionnaire should be sent to as many insurance companies as possible. The questionnaire should seek to establish:

(i) Background information such as age and sex of persons injured, locality, severity of accident, degree of personal injury (if any), number of casualties and number of vehicles etc.

(ii) Type of Insurance: comprehensive, fire and theft or third party only.

(iii) The payment for damage for the insured vehicle and for damage to vehicles and other property belonging to third parties.

Efforts should be made to ensure that information collected is representative of national accident figures. Thus proportions of the different categories of personal injury accidents and types of vehicles involved should be as close as possible to the national figures in order that the sample is not biased and is satisfactory from the point of view of coverage.

An estimate will have to be obtained of the total number of damage-only accidents taking place. In most countries these do not have to be reported to the police and accurate statistics are therefore likely to be unavailable. It may be possible to obtain an estimate from personal records which can indicate the number of vehicles involved in damage accidents per vehicle involved in personal injury accidents.

Having collected information on the average cost of repair of vehicles involved in fatal, serious, slight and damage-only accidents, the average number of vehicles involved in these classes of accident needs to be determined from national accident statistics. By multiplying cost per vehicle

by number of vehicles involved, the average cost of vehicular repair per accident (by degree of severity) is obtained.

In a road accident, damage may also occur to movable property such as goods or personal effects carried by vehicles or to fixed property such as walls, lamp standards, signs etc. information on claims for damage to property of third parties could again be obtained from insurance companies. Information on the cost of damage to street furniture can best be obtained from local authorities.

4.1.4. Administrative and Police Costs

Other costs that arise as a result of road accidents include those associated with the administration of insurance, the police and court proceedings and possibly with the delays caused to other vehicles at the scene of the accident. None of these costs are particularly easy to determine. In Ethiopia, as obtained from interview with insurance workers, 20% of the total cost of all insurance costs is set against administrative expenses. However, it has been tried to obtain information on the average costs of police and administration for road accidents for each level of severity by examining the police records of some accident victims, it was found that there is no clear indicatives to arrive at this cost component. Therefore, the percentage proportion proposed by TRL, Ross Silcock Partnerhsip (2001) for estimating this cost component in Ethiopia is utilized in this study and the values are 10% of damage only cost, 0.2% of the total resource cost of fatal casualty, 4% of the total resource cost of serious casualty and 14% of the total resource cost of slight casualty [20].

4.1.5. Pain, Grief and Suffering Costs

Although it is difficult to express pain, grief and suffering in monetary terms, it is necessary to estimate the costs of accidents which directly or indirectly fall upon individuals suffering bereavement. Moreover they are costs which the community would usually be prepared to meet in order to avoid the misery involved. If the costs given in this paper are to be used in the

economic assessments of road improvements, then it is important that they should reflect the value that the community places on the saving of life and the avoidance of suffering.

It would therefore appear to be necessary to try to estimate the value that the community places on the avoidance of loss of human life. As stated earlier, this ought ideally to be done using the willingness-to-pay approach to the valuation of safety and the costing of risk. However, implementation of such an approach in a developing country will be no easy matter, the ideal willingness-to-pay based costs and values might be approximated by adding an allowance for "pain, grief and suffering" to gross output figures.

Early attempts to cost "pain, grief and suffering" in road accidents in the UK made use of awards made in courts in relation to people killed and injured in accidents. This provided some insights into possible values that could be used. The figure of £5000 was taken to reflect the minimum value accorded by society to the avoidance of pain, grief and suffering associated with premature death [8].

Fairly arbitrary values of £500 were later added to the cost of serious accidents and £15 to slight accidents. These sums represented additions to the total resource costs derived for fatal, serious and slight accidents with slight amendment 38%, 100% and 8% respectively. However, the study conducted in Ethiopia proposed the sums to be added to reflect pain, grief, and suffering to be 50%, 120% and 15% of the resource (i.e. quantifiable) costs derived for fatal, serious, and slight injury accidents. In this study, however, neither of these values are used rather estimate of this cost component is made based on data obtained from life insurance, government regulation, and court awards.

4.1.6. Under-reporting

A study by TRL, Ross Silcock Partner (2001) estimated that the true number of fatalities to be 20-30 percent greater and the total number of road casualties to be twice or more than being currently reported in police statistics. It stated that this estimate should be considered conservative as such levels of under-reporting are found in many countries, with significant under-reporting of injuries in motorized countries including the UK.

It also added that under-reporting of road casualties in Ethiopia is also widely acknowledged by both police and medical professionals. The study further puts three reasons for arguing that the human casualty toll from road accidents is much greater than officially reported by the police; these include severity ratios, hospital data and reporting procedure.

4.2. Data Collection

Data required for this study using the gross output method are inputs for the cost components. The accident costs can be derived by using accident severity data obtained from the Federal Traffic Police Office.

4.2.1. Data Sources

Two main categories of data exist: road accident data and unit cost data. The following are the sources of these data.

(i) Road accident data, which are classified into four degrees of severity (fatal, serious, slight, and property damage only accidents), is obtained from the Traffic Police Department, while the number of casualties, which are classified into three degrees of severities (fatality, serious injury, and slight injury), were also acquired from Traffic Police Department.

(ii) Unit cost data consist of the following components, as presented in Table 4.1.

Table 4.1: Summary of Data Requirements and Sources of Each Cost Component

Cost components	Data Requirements	Data Sources
Hospital and Medical costs	✓ Individual hospital and medical expenditure, ambulance costs	❖ Hospital and medical records from Jimma University Specialised Hospital, Minilik II referral Hospital and Adama Hospital
Loss of Output	✓ For fatal casualties – individual fatal age, average age retirement, and average national income statistics ✓ For serious and slight casualties – time lost for rehabilitation ✓ Loss of outputs and costs of family members in taking care of victims ✓ Loss of outputs of drivers causing deaths and put in jail ✓ Loss of outputs of damaged vehicles while in repair	❖ Ministry of social affairs ❖ Hospital and medical records from hospital ❖ Central Statistical Agency ❖ Police Accident Record
Property Damage Cost	✓ Vehicle damage cost	❖ Insurance Companies ❖ Transport Companies (Public & Freight) ❖ Garages
Insurance Administrative Cost	✓ Accident investigation, court proceeding and claim overhead	❖ Insurance companies ❖ Police Departments
Human Cost	✓ Court Award for peoples killed and injured in accidents ✓ Cost proportion for fatal, serious, and Slight accidents	❖ Police Traffic Records ❖ Insurance Companies ❖ Similar Literatures

4.2.2. Data Requirements

4.2.2.1. Road Accident Data

To calculate total accident costs, the number of accidents and casualties by severity must be known though the accident data compiled in developing countries like Ethiopia suffers incompleteness and inconsistent. Casualty figures need to be obtained separately for each accident severity type to carry out cost estimation. This accident data should comprises to the minimum the following major items as shown in Table 4.2.

Table 4.2: National Accident Data Requirements

Accident Type	Number of Accidents	Number of Casualties		
		Fatality	Serious Injury	Slight Injury
Fatal	Xx	xx	Xx	xx
Serious	Xx	-	Xx	Xx
Slight	Xx	-	-	Xx
Damage Only	xx	-	-	-

For this particular study the road accident data required include, but not limited to, national road traffic accident statistics with a particular focus on the number of accidents in terms of accident casualties that is fatal, serious, slight or damage only. And also it is required to obtain the number of road traffic casualties in terms of age and accident severity. These data were collected from Federal Traffic Police office. It comprises summary of national traffic accident statistics for the years 2007/08, 2008/09 and 2009/10. The data compiled from this office is annexed.

4.2.2.2. Unit Cost Data

i. Hospital and Medical Costs

It includes costs from inpatient services like costs of operations, X-rays, medicines, doctor services, and food and bed as well as from outpatient services like rehabilitation costs, prosthetic costs, and funeral costs.

Data required for medical costs are collected from three different hospitals namely: Minilik II referral Hospital, Jimma University Specialised Hospital, and Adama Hospital to make the data more comprehensive and representative of the national figure.

At the first stage a data collection form, comprising lists of items that are believed important to come up with medical cost estimate, was prepared considering the availability of the data in the hospital records. Of course some of the data could only be obtained by making an interview with particular targeted hospital staffs and accident victims. The data collection form used in collecting medical cost data is annexed.

Basically there is no separate record for road traffic accident victims in these hospitals. Rather there is a separate cupboard for all trauma cases meaning any type of accidents including road traffic accidents, falling, fire, biting etc. It was very tiresome to sort road traffic accident records from these trauma cases. Finally about 160 records in the year 2009/10 and 140 records in the year 2008/09 from Jimma Hospital, 200 records in the year 2009/10 from Minilik Hospital, and 220 records from Adama Hospital have been sorted for road traffic accident victims .

It was very difficult to understand the content of the records for non-medical professionals and therefore a person with medical profession has been used to assist in gathering required information from the records particularly from Jimma Hospital. And taking the experience from this Hospital it has been tried to collect the data from Minilik and Adama Hospitals. It is important to note that the way of information put in individual records is very poor to clearly understand the actual history of the victim during his stay in the hospital. Big effort is expected from hospital administrator in particular and Ministry of Health in general to improve the matter.

Actually there are data required for medical cost estimates which could not be obtained from individual victim records. These data includes cost of one-day in-patient treatment (administrative staff costs, meals, bed etc.), number of inpatients visited by a doctor in one day, number of inpatients taking care by a nurse in one day, nurse salary and others. These data may be obtained by making interview with the trauma ward head, hospital administration head and general practitioners. And also costs of some medical services like operation and costs of medicines provided for the victims was obtained by asking doctors and local pharmacists. The form used to collect such data is also annexed.

ii. Loss of Output

It is the loss of productivity due to premature death, minor and major injuries from those affected by road accidents. The main data required for lost output estimation are the average wages of the casualties and care givers and the amount of time lost due to road accidents.

As it is tried to explain in the methodology part of this paper finding data or information explaining the average wages of casualties is very difficult and hence a national figure describing the per capita income of individuals, as obtained from statistical abstract January 2011, CSA, is

used to estimate the loss of output. And the average age of retirement was obtained from Ministry of Workers and Social affairs. The amount of time lost due to road accidents by the victims and their care givers was obtained from hospital data on the other hand the time lost due to road accidents by the drivers causing deaths and put in jail was obtained from police traffic records. The national population and income statistics were obtained from statistical abstract January 2011, CSA [16].

iii. Property damage cost

It includes the cost of vehicle damage, property inside the vehicle (usually goods in transit) and the cost of public road side property damage.

The required data for this cost estimation are obtained from three Insurance Companies namely: Ethiopian Insurance Corporation, Awash Insurance Company, and United Insurance Company. Even though a data collection form was prepared for gathering detail information to come up with estimate of the cost for vehicle damage and insurance administrative costs, the information obtained is rather more general and limited. However, it has been tried to reorganize the available data in the way it would be useful to incorporate in this study. Accordingly the data is sorted to show the amount of claims paid, the number of vehicles involved with respect to the vehicle type, and with respect to the severity of the accident.

iv. Administrative Costs

It includes those associated with the administration of police services, court proceedings, insurance, and others.

However, it has been tried to obtain information on the average costs of police and administration for road accidents for each level of severity by examining the police records of some accident victims, it was found that there is no clear indicatives to arrive at this cost component. Therefore, the percentage proportion proposed by TRL, Ross Silcock Partnerhsip (2001) for estimating this cost component in Ethiopia is utilized in this study and the values are 10% of damage only cost, 0.2% of the total resource cost of fatal casualty, 4% of the total resource cost of serious casualty and 14% of the total resource cost of slight casualty.

v. Pain, Grief and Suffering

To compensate for the social loss resulting from road accidents in estimating accident costs, the human costs that account for pain, grief and suffering were usually added to the total unit costs for each severity type of accident. Accordingly, the study conducted in Ethiopia proposed the sums to be added to reflect pain, grief, and suffering to be 50%, 120% and 15% of the resource (i.e. quantifiable) costs derived for fatal, serious, and slight injury accidents. However, this study has used the data obtained from life insurance, government regulations, and court awards to arrive at a more reliable cost figures rather than simply using proportions proposed by other countries which might have different culture, norm, and social life systems.

5. Data Analysis and Discussions

5.1. Accident Statistics

This study is done based on cross sections of data for the years 2008/09 and 2009/10 and the analysis is carried out separately for each year to compare the results. Care has been taken to consider data sets which have only reflected the events in that particular period for this study.

Road accident statistics are compiled by Ethiopian Federal Police Commission. This office gathers monthly summaries from each region and routinely keeps summary of records. Since there is no standard form of reporting the accidents, the detail depends on the traffic officer who attended the accident scene. According to the report of Ethiopian Federal Police Commission a total of 15086, 15695 and 13677 vehicles were involved in road accidents during the year 2007/08, 2008/09 and 2009/10 respectively. There were 2161, 2613 and 2121 persons killed due to road accidents and 2156, 2276 and 2107 persons were seriously injured and also 2123, 2221 and 1852 persons were slightly injured during the three respective years. Damage only accidents (i.e. no one injured but damage to vehicles) occurred within these years was 9005, 8987 and 7098 respectively. Accordingly the number of accidents and the corresponding number of casualties for different severity of accident is shown in table 5.1 for the year 2008/09 as a sample.

Table 5.1: Comparison of No. of accidents and casualties for different severity in 2008/09

Accident Type	Number of Accidents	Number of Casualties	Casualty/Accident Ratio
Fatal	2211	2613	1.18
Serious	2276	4177	1.84
Slight	2221	4312	1.94
Damage Only	8987	-	-

5.2. Damage to Vehicle Cost

Damage to vehicle cost is estimated based on the information collected from three Insurance Companies namely: Ethiopian Insurance Corporation, Awash Insurance Company, and United Insurance Company on the costs of repairing the vehicles involved in the road accidents in

Ethiopia. These insurance companies keep records of all the expenses paid to third parties or to policy holders. Detail information is collected totally on 600 motor vehicle damage claims from Awash and United Insurance Companies for the year 2009/10. The data mainly composed of important information like the type of vehicle, accident severity, and claims paid.

Table 5.2: Summary of Claims paid for different types of vehicles and accident severity

Type of Vehicle	Accident Severity				Total	Claims Paid (Birr)			
	Fatal	Serious	Slight	Damage Only		Fatal	Serious	Slight	Damage Only
Cars	7	17	25	54	105	147000	391000	375000	270000
Station Wagon	6	10	18	20	54	240000	250000	225000	150000
Trucks (<=40 qt)	22	48	25	38	133	1650000	3840000	1375000	1140000
Trucks (> 40 qt)	6	11	17	57	91	840000	1815000	1020000	2280000
Minibus < 13 seats	16	28	49	63	158	672000	1008000	686000	504000
Buses (> 13 seats)	3	6	13	19	41	135000	300000	221000	152000
Others	2	2	6	7	17	112000	128000	62000	63000
Total	**62**	**122**	**153**	**263**	**600**	**3796000**	**7732000**	**3964000**	**4559000**

Detail information is collected on 600 claims paid for motor vehicles involved in road traffic accidents for the year 2009/10. As the table shows the collected data are summarized as the claims paid for different types of vehicles according to the level of severity of the accident. From these data we can produce values of average claims paid for each vehicle type under each accident severity category and are shown in the Table 5.3 below.

Table 5.3: Claims paid for vehicles involved in traffic accidents

Type of Vehicle	Average Claims Paid (Birr)/vehicle			
	Fatal	Serious	Slight	Damage Only
Cars	21000	23000	15000	5000
Station Wagon	40000	25000	12500	7500
Trucks (<=40 qt)	75000	80000	55000	30000
Trucks (> 40 qt)	140000	165000	60000	40000
Minibus < 13 seats	42000	36000	14000	8000
Buses (> 13 seats)	45000	50000	17000	8000
Others	56000	64000	31000	9000

Moreover the data is also collected from Federal Police Statistics for the year 2009/10 on the number of accidents with respect to vehicle type and accident severity and is reorganized as required for this analysis and it is shown in Table 5.4 below.

Table 5.4: Accident statistics with respect to type of vehicle

Type of Vehicle	No. of Accidents in 2009/10			
	Fatal	Serious	Slight	Damage Only
Cars	110	234	77	1673
Station Wagon	43	61	113	854
Trucks (<=40 qt)	552	602	702	1337
Trucks (> 40 qt)	536	366	368	915
Minibus < 13 seats	321	557	1017	1792
Buses (> 13 seats)	168	186	209	417
Others	122	100	135	110
Total	**1852**	**2107**	**2620**	**7098**

Having the data on the number of accidents and the corresponding costs of property damage for each vehicle type and severity class, the total property damage cost can now be calculated as the product of the two i.e. number of accidents x cost per vehicle damage and the result is tabulated below.

Table 5.5: Property damage cost with respect to vehicle type and accident severity

Type of Vehicle	Property Damage Cost (Birr)				Total
	Fatal	Serious	Slight	Damage Only	
Cars	2,307,746	5,377,902	1,147,956	8,366,315	17,199,919
Station Wagon	1,724,898	1,530,248	1,406,809	6,403,649	11,065,603
S.Trucks (<=40 qt)	41,418,412	48,184,434	38,625,345	40,100,752	168,328,943
L.Trucks (> 40 qt)	74,977,411	60,395.809	22,058,764	36,615,120	194,047,104
Minibus < 13 seats	13,495,934	20,052,363	14,243,659	14,332,661	62,124,617
Buses (> 13 seats)	7,574,249	9,303,905	3,545,909	3,338,531	23,762,594
Others	6,855,078	6,424,591	4,186,663	985,730	18,452,062
Total	**148,353,727**	**151,269,252**	**85,215,105**	**110,142,759**	**494,980,842**

As it is shown in the table the analysis results with a cost value of 148.35 million Birr for fatal, 151.27 million Birr for serious, 85.22 million Birr for slight, and 110.14 million Birr for damage only accidents in the year 2009/10. This sums a total amount of 494.98 million Birr as a cost of vehicle damage in the country in 2009/10.

For the sake of comparison the cost estimated by Federal Police for property damage is considered, and it is 253.45 million Birr in the year 2009/10. When compared with the estimated

cost of 494.98 Million Birr based on the insurance data, there is a big discrepancy. This clearly shows there is a gap between insurance companies and traffic police offices to exchange relevant data among them.

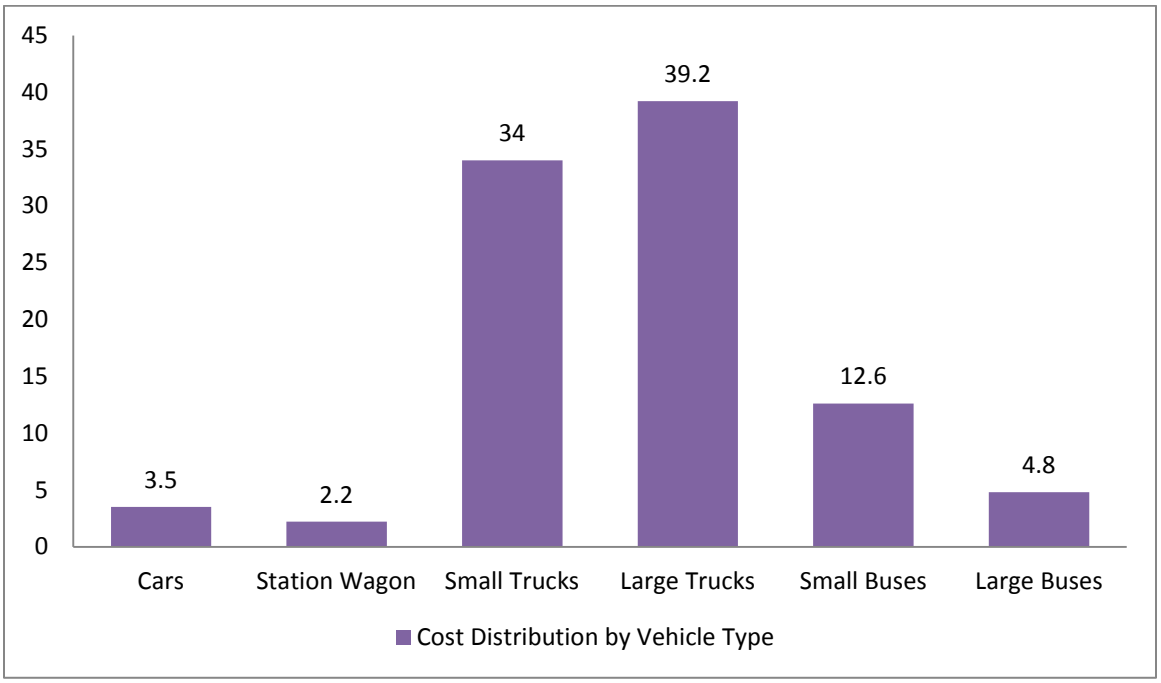


Fig. 5.1: Cost Distribution by Vehicle Type

As it can be seen from the chart about 73% of the total cost of property damage is contributed by trucks i.e. small and large trucks followed by small buses which have a share of about 13% of the property damage cost. This indicates that any measures taken to reduce truck accidents will significantly bring a huge economic savings for the country. For example if there is any strategy that can bring a truck accident reduction by 15%, there will be an economic savings of about fifty five million birr (55,000,000). Imagine how significant the savings will be for countries like Ethiopia.

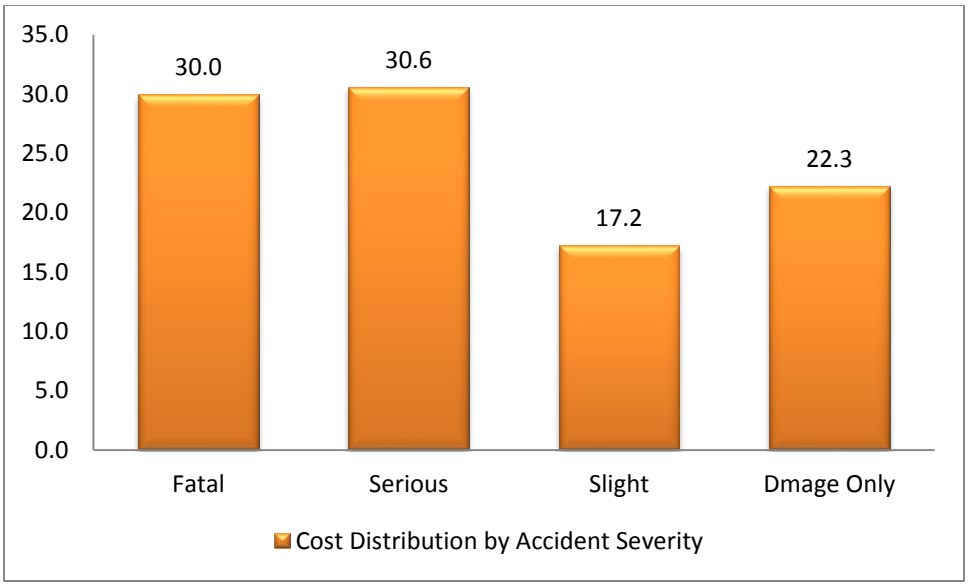


Fig. 5.2: Cost Distribution by Accident Severity

From the chart it can be shown that fatal and serious injury accidents account more than 60% of the total cost of property damage cost. Here also it can be said that any mechanism that brings reduction in fatal and serious injury accidents will definitely results in significant economic savings.

5.3. Lost Output Cost

Road accidents could lead to a loss of output in the year in which the accidents occur and in future years. In order to determine lost output certain assumptions have to be made. In the case of fatal accidents obtaining the average age of road accident fatalities and subtracting this from the average age at which the person ceases to work gives the number of "person years lost" and also the lost output due to drivers causing death accident and put into prison is obtained by determining the number of years the driver lost at his stay in jail as a punishment. In the case of serious accidents, estimates must be obtained of the average number of days that the injured person spends in hospital together with the number of days they stayed at home recovering from the accident. In the case of a slightly injured person, an estimate must be obtained of the number of days that the person is off work due to receiving treatment (as an outpatient) for their minor injury, or convalescing at home [6].

The statistics for road traffic accident casualties compiled by Ethiopian Federal Police Commission has classified fatal accidents by age. Accordingly the average age of road accident fatalities has been calculated for each age group by using the weighted average system. In Ethiopia civil servants retire at the age of 60 years and the corresponding years of lost output following fatal road accidents is shown in the table 5.6 below for each age group.

Table 5.6: Years of Lost Output with respect to Age Group

Age Group	Average Fatal Age	Years of Lost Output
< 7 Years	3.5	56.5
7 - 13 Years	10	50
14 - 17 Years	15.5	44.5
18 - 30 Years	24	36
31 - 50 Years	40.5	19.5
>51 Years	55	5

Having derived estimates of the average number of years lost following road accident fatalities, the monetary values of those lost years must be determined. This is obtained by using the annual per-capita income of individuals in the nation. Of course it would be better if wage rates of different income groups are used to determine the monetary values, however it has been tried to acquire such data but it is not available and as a result the per-capita income of individuals is used in place. The GDP of Ethiopia for the fiscal year 2009/10 is 383364 million Birr (Statistical Abstract, 2011) and the projected population (based on the 1997 population census result) for this period was 78.8 million(Central Statistical Agency, 2011) [16]. This leads to an annual per capita income of 4865 Birr.

Table 5.7: National Average Net Income per Capita

Year	Population (million)	GDP at Current Market Price (million)	Per Capita National Income (Birr)
2000/01	61.6	68,027	1,104
2001/02	63.2	66,557	1,053
2002/03	64.8	73,432	1,133
2003/04	66.5	86,661	1,303
2004/05	68.3	106,473	1,559
2005/06	70.0	131,641	1,881
2006/07	72.4	171,989	2,376
2007/08	74.9	248,605	3,319
2008/09	76.8	335,380	4,367
2009/10	78.8	383,364	4,865

Source: Central Statistical Agency, Statistical Abstract 2011

The total average lost output for fatal road accident is the sum of each future year's lost output, estimated as follows [7]:

$$\text{Lost Output (fatality)} = \sum_{i=1}^{N} \frac{W(1+g)i}{(1+r)i} \qquad (5.1)$$

Where: W: average yearly per capita GDP
r: discount rate;
g: growth rate of the economy
i: average number of years of lost output per fatality accident.

Table 5.8: Expected GDP Growth in Ethiopia

Period	National GDP Growth (% pa.)		
	Low	**Medium**	**High**
2010-19	6.0	7.0	8.0
2020-30	5.0	6.0	7.0

(Network Analysis, Final Report (2003), ERA (refer to the IMF/World Bank Analysis and Forecast); And Economic Report on Africa 2002, UNECA)

Assuming economy of Ethiopia will grow in medium rate, a 6.5% growth rate can be considered for this analysis. The country's economists and planners use 10% discount rate, which is often based on the inflation rate. Thus the total lost output for fatality accident for each age group is shown in the table 5.9 below.

Table 5.9: Lost Output cost versus accident age group

Age Group	Average Fatal Age	Years of Lost Output	Total lost output per victim (Birr)	Number of fatal casualties	Total Lost Output cost (Birr)
< 7 Years	3.5	56.5	123,815	104	12,876,760
7 - 13 Years	10	50	118,644	197	23,372,868
14 - 17 Years	15.5	44.5	112,333	267	29,992,911
18 - 30 Years	24	36	101,817	596	60,682,932
31 - 50 Years	40.5	19.5	67,909	741	50,320,569
>51 Years	55	5	22,100	216	4,773,600
Total					**182,019,640**

Thus, the total lost output cost is estimated to be 182.1 million ETB.

There is also a loss of output due to driver committing death injuries and are put in jail. In Ethiopia the minimum time period that a driver committing a fatal injury will stay in prison is 5 years. This is an output loss to the country by the driver population making same mistakes. The lost output cost per driver is about 22,100 ETB. Assuming drivers are accused of all pedestrian and passenger fatalities which is about 90% (1910) of all fatal casualties. Therefore, the total lost output cost due to drivers is estimated to be 42.2 million ETB.

In the case of seriously injured casualties the lost output cost is estimated, as mentioned before, from the average number of days inpatients stay in hospital and take rest at home. Moreover, these lost output cost also considers the number of days elapsed by care givers in taking care of inpatients. These data could have been obtained from sources published by the Ministry of Health or Bureau of Statistics, but there is no such statistics. From the emergency treatment sections of the three mentioned Hospitals, relevant data from 600 traffic accident cards in the 2009/10 were collected. From these cards, the average number of days an inpatient stay in hospital was found to be 33 days. And also the interview with the doctors in the hospitals showed that a severely injured person will stay about 10 days at his home recovering from the accident and on the other hand on average there are two care givers for each inpatients. Thus the total lost output is estimated to be 1453 Birr for seriously injured person including lost output of care givers. Accordingly the total cost of lost output for seriously injured casualties becomes 4.05 million Birr.

The lost output cost for slight injuries is estimated from the number of days an outpatient takes rest at home. Accordingly from the interview with doctors and outpatients an outpatient person/slightly injured person could be off work for about 6 days due to receiving treatment for their minor injury. And thus the total cost of lost output is estimated to be 80 Birr per slightly injured casualties. This results on the total lost output cost of 0.29 million ETB.

Table 5.10: Summary of Lost Output Costs

Year 2009/10	Type of Casualty	Values
retirement age (years)		60
average age of victim (years)		33
GDP (million Birr)		383364
Population (million)		78.8
per capita income (Birr)		4865
Discount rate (%)	Fatal	10
Growth rate (%)		6.5
no. of casualties		2121
total lost out put cost by drivers (million Birr)		42.2
total lost out put cost (million Birr)		**224.3**
no. of days lost by a victim (day)	Serious	43
no. of days lost by care givers (day)		33
lost output per person (Birr)		1453
no. of casualties		2789
total lost out put cost (million Birr)		**4.05**
no. of days lost by a victim (day)	Slight	6
lost output per person (Birr)		80
no. of casualties		3655
total lost out put cost (million Birr)		**0.29**
Grand total lost output cost (million Birr)		**228.58**

5.4. Medical Costs

It has been tried to collect as much relevant information as possible though it is difficult to obtain all the required data only from hospital. Based on the possible data that could be available the data collection form is redesigned. Basically there are data which are obtained from the victim's medical records like duration in the hospital, x-ray, medication, operation etc; and there are also some data which can only be obtained by making interview with appropriate personnel in the hospital like the daily cost of food and bed, the average number of bed in a trauma ward, the number of victims visited by a doctor per day etc. Medical treatment in Ethiopia is highly subsidized by the government. As per the information obtained from Hospital administrators and medical directors the government provides about 85% of subsidy for medical treatment in these hospitals. The sample survey made on some private medical centers proves this value. For instance the average one day cost for meal and bed is about 45 Birr per inpatient in government hospitals whereas in private medical centers this costs about 400 Birr per day per inpatient.

Based on the information collected from the three Hospitals a detail analysis is made by which the medical costs per patient for different components are estimated. The analysis shows that the cost of one day inpatient treatment (including administrative staff costs, meals and bed, etc) is 300 Birr. Of course this cost includes the subsidy provided by government which is about 85%. The overhead costs per patient (medicine, doctor visits, and nurses' care) are 1420 Birr. The average cost of operation per seriously injured person is 1745 Birr. Cost of radiology per patient (X-Ray & CT-Scan) is calculated to be 252 Birr on average. The prosthetic/orthotic costs per victim are 82 Birr on average. The average cost of laboratory for trauma inpatient is 51 Birr. For outpatients the overall average cost is 725 Birr (the cost includes subsidy of the government) per slightly injured person. For fatal casualties the average cost of operation is 510 Birr and the overhead cost is 355 Birr.

Table 5.11: Medical Costs

Year	2009/10		
	fatal	**serious**	**slight**
one day inpatient treatment cost (Birr)	300	300	-
no. of days inpatient stay in hospital	8	33	-
over head costs per patient (Birr)	355	1420	-
operation cost per person (Birr)	510	1745	-
radiology (x-ray & CT-scan) cost per person (Birr)	135	252	-
prosthetic/orthotic costs per person (Birr)	0	82	-
laboratory costs per person (Birr)	21	51	-
total medical cost per person (Birr)	3421	13450	-
outpatient treatment cost per person (Birr)			725
no. of casualties	2121	2789	3655
Total medical cost (million Birr)	**7.26**	**37.51**	**2.65**

5.5. Police and Administrative Costs

As it is mentioned in the data collection part it has been tried to follow some accident records to understand the cost components that could be incorporated under this cost category. However, it was found that there are no clear indicatives to arrive at this cost component. The information obtained from insurance companies shows that insurances consider their administrative costs to be 20% of the claims paid for motor traffic accidents. But they don't have any separate estimate of administrative costs for each severity of the accident. Of course finding such information

seems a universal problem. Therefore, the percentage proportion proposed by TRL, Ross Silcock Partnerhsip (2001) for estimating this cost component in Ethiopia is utilized in this study and the values are 10% of damage only cost, 0.2% of the total resource cost of fatal casualty, 4% of the total resource cost of serious casualty and 14% of the total resource cost of slight casualty. Accordingly the police and administrative costs of road traffic accidents in the year 2009/10 is found to be 7.5 million Birr for fatal, 7.8 million Birr for serious, 12.3 million Birr for slight, and 11.1 million Birr for damage only accidents.

5.6. Pain, Grief and Suffering Costs

Although, it is difficult to express pain, grief and suffering in monetary terms, it is necessary to estimate the costs of accidents which directly or indirectly fall upon individuals suffering bereavement. In the absence of more detailed research targeted at societies and economies in low income countries, it is suggested to add 38%, 100% and 8% of the total resource cost of fatal, serious and slight casualties, respectively as costs of pain, grief and suffering for fatal, serious and slight casualties (see BTRL report, 1995). However, these percentages might not describe the situation in Ethiopia due to the norm, culture and social life is quite different. For this reason it has been tried to estimate these costs from life insurance, court award, and government regulations. The information obtained from Awash Insurance company shows that about 4990 individuals have got life insurance with an amount of 436,133,671 Birr and when the average is taken each individual have put 87,401 Birr as their life insurance cost. Whereas the government has put 30,000 Birr as life compensation and the court award is made based on the amount the person put for his life insurance if he is insured or the amount set by the government if he is not insured. However, for this study the amount set by individuals for their life in terms of life insurance is used because it is based on individuals' willing unlike the amount set by government. Accordingly the estimated cost of pain, grief and suffering for the year 2009/10 due to road traffic accident is found to be 185.38 million Birr for fatal casualties.

On the other hand from the same insurance company information was obtained on 5052 individuals who have obtained health insurance with an amount of 197,704,784 Birr which results on average amount of 39,133 Birr per individual as health insurance cost. In this study this value is used as the human cost for serious injury. Hence the estimated cost of pain, grief and

suffering for the year 2009/10 due to road traffic accident is found to be 109,141,937 Birr for serious casualties.

In this study for slight injury casualties the cost of pain, grief, and suffering is estimated from emergency medical treatment cost set by government for third party insurance which is 500 Birr per accident victim. Using this amount the total cost of pain, grief, and suffering for the year 2009/10 due to road traffic accident is found to be 1,827,500 Birr for slight injury casualties.

5.7. Adjusting Resource costs for Under-Reporting

As stated earlier it is expected that significant under-reporting of injuries exists in developing countries like Ethiopia. A study conducted in Ethiopia by TRL, Ross Silcock Partner (2001) have raised the total cost of fatal accident by 25%, and have increased serious and slight injuries by 100% meaning the values reported by police statistics will be doubled when under-reporting is considered whereas the study proposed a ration of 5:1 as a ratio of damage only to injury accidents considering the effect of under-reporting. In the absence of a better baseline to consider for under-reporting the proportions suggested above for fatal and injury accidents are used for this study but for damage only accidents the ratio of damage only to injury accidents based on police statistics is 1.5:1 whereas that proposed by the previous study is 5:1; hence to make the analysis more conservative the smaller ratio of 1.5:1 is used in this study. In this case when the fatal accident is raised by 25% it will become 2651 fatal casualties, considering an increase of injury casualties by 100% this will become 12888 injury casualties, and using a ratio of 1.5:1 damage only to injury accidents the damage only accidents becomes 19332. In other words the total cost estimated using the police statistics should be adjusted by 1.25 times for fatal, 2 times for injuries, and 2.7 times for damage only accidents. Therefore the grand total cost of road traffic accidents for different severity level considering under-reporting is summarized in the table below.

Table 5.12: Summary of costs of road traffic accidents (2009/10)

	Fatal	Serious	Slight	Damage-only	Total
Damage to vehicle	148,353,727	151,269,252	85,215,105	110,142,759	494,980,842
Lost Output	224,230,640	4,052,417	292,400	-	228,575,457
Medical	7,255,941	37,512,050	2,649,875	-	47,417,866
Police and Admin.	7,596,806	7,713,349	12,342,033	11,014,276	38,666,464
Pain, grief & Suffering	185,377,521	109,141,937	1,827,500	-	296,346,958
Adjustment for Under-reporting	(1.25X)	(2X)	(2X)	(2.7X)	-
Total	**716,018,294**	**619,378,010**	**204,653,826**	**327,123,995**	**1,867,174,125**

6. Conclusions and Recommendations

6.1. Conclusions

By identifying the total impact of road accidents, road accident costing reveals the true extent of the problem in both the human casualty toll and also in economic terms. Road accidents pose a serious drain on scarce financial resources and medical services. Road Traffic Accident victims mainly belong to the most productive age range and have often just begun to pay back their debts to society.

This study shows that the national economic losses resulting from road accidents in Ethiopia are considerably high, even if the conservative human capital method is employed in estimating. Based on data and economic figure of 2009/10, road accident costs of Ethiopia were calculated. The cost of damage only, slight, serious and fatal road traffic crashes were 327.12, 204.65, 619.38, and 716.02 million Birr respectively in the year 2009/10. This represents the total national economic loss resulting from road accidents to be estimated as 1.87 Billion Birr which is equivalent to 145.07 Million USD considering the exchange rate of the same year, or approximately 0.49% of the gross domestic product of the country in the same year.

Based on this estimated annual road accident cost, it can be said that road accidents do not cause only losses in lives of productive members of the population and a substantial number of disabilities and injuries but also generate a gigantic loss to the country's economy. It is timely to urge all agencies concerned to put forward more efforts, as well as sufficient manpower and other resources, to effectively address the road traffic accident problems. There is the need for more efforts and resources to be channeled to address the issues of road traffic safety in the country.

Even though intangible costs (lost output and human costs) are big burden of victims and their families, friends and relatives as well as a whole society, those costs are unrecognizable yet to people. The estimation of those intangible costs among the overall costs of road accident is to highlight appropriate recognition and awareness of a whole society to traffic safety aspect. It is necessary that the government should invest more into traffic safety database system to have better statistics and data of road accidents. It would be very useful for the analysis and decision making in improving the road traffic safety in the country.

6.2. Recommendations

This study firmly believes that decision makers as well as the society realize how serious accident losses are for the Ethiopian society. A duty of all parties concerned is therefore to use these estimates to persuade the Government to (i) play a more active, if not proactive, role in promoting road safety and (ii) allocate sufficient resources, particularly financial resources, to help alleviate this severe health problem in our country.

The economic benefits of investing in road safety improvements (in road design and layout, education, training and enforcement) can be greatly appreciated if the national annual cost of road accidents can be properly estimated. To achieve this, resources for developing a better road accident costing database is crucial, so that better and more estimates can be obtained. It is important for the Government to declare the lack of road safety an urgent problem, if research on the economic and human cost of traffic injuries is conducted, and use modern strategies and tools to raise awareness about this issue. There must be cooperation across many sectors in the country; health, education, transport, and law enforcement. A workforce that will tackle injury prevention and control (i.e., in media and communication, economic analysis, and policy development) must be built. Road traffic accidents can be prevented by taking action, including raising awareness of and enforcing laws governing like speed limits.

On the other hand even though the police report shows different accident severity categories a documented definition of these categories could not be obtained and the information obtained from the interview of some accident investigator polices indicate that a fatal casualty is the one who has died due to road traffic accident in the reporting year meaning that it is considered as fatal even if it exceeds a month, 6 months or more but within the reporting year. This shows that Fatal casualty definition used in Ethiopia is different from most countries' practice. Therefore, this study recommends that the country's definition should follow the international practices so that this accident statistics can appropriately used for any international comparison purposes.

It is recommended that an effort has to be made to improve the country's road accidents data base system. The database shall also accommodate relevant information from hospitals and insurance companies. In this regard the concerned body should cooperatively work with insurances to gather summary of statistics on the costs of vehicle repair periodically and with

Ministry of Health to have a separate section for road accident casualties in its vital registration books and routine publications.

As it can be seen clearly in this research under-reporting has been considered using very crude and general values proposed by previous studies. However, a separate detail study on under-reporting of traffic accidents is very much required and this study strongly recommends conducting research on this topic to arrive at a more dependable and realistic estimate.

So far there is very limited researches conducted in the area of road safety in Ethiopia. Still research efforts are strongly required in this regard. For instance reducing the number of fatal accident will result in huge economic savings. There is also high economic returns in any research effort that can reduce accident severity and frequency.

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