



The cost of traffic accidents in Singapore

H.C. Chin

Department of Civil Engineering, National University of Singapore, Singapore.

Abstract

This paper estimates the economic cost of traffic accidents in Singapore so that further investments in road safety research and road accident prevention can be better evaluated.

The Gross Output method is chosen in the analysis. It takes into account the loss of current and future resources resulting from accident occurrence as well as medical, administration, property damage costs and human costs of suffering.

The study shows that at 1999 prices, the cost per traffic fatality is S\$1.273 million (S\$1 US\$0.56) while that of a serious injury and a slight injury is S\$163,000 and S\$12,000 respectively. The total economic cost of road accidents for 1999 is S\$976.6 million which is about 0.7% of the Gross Domestic Product. These conservative estimates should assist the relevant authorities to consider increasing funding for road safety research as well as road accident prevention programs.

1 Introduction

Among transportation accidents, road accidents are generally given less public attention. Road accidents tend to be less dramatic because of their frequent occurrence, compared to, for example, air transport accidents which occur rather infrequently but usually result in many deaths. Consequently, the large-scale economic and social impact may not be so much appreciated. Where estimates are available, accident costs are found to be considerable. For example, the total cost



per fatal road accident was estimated as 983,710 (at 1996 prices) in the United Kingdom [1] and US\$977,000 (at 2000 prices) in the United States [2].

On the other hand, information regarding the costs of road accidents is important if governments are to accord equitable priority in resource allocation for accident prevention programs. In many European countries, detailed cost evaluations of road accidents are made periodically [1, 3-5]. The United States and Canada have also used various approaches to estimate road accident costs [2, 6] while Australia and New Zealand have established similar costing analyses to facilitate their decision-making process for investments in traffic safety countermeasures [7, 8].

A number of Asian countries, including Vietnam and Nepal, have also undertaken similar accident cost analyses [9-10]. Interestingly, even though one of the most developed countries in Asia, Singapore has not made any formal analysis on road accident costs. The oft-cited reason is that there are insufficient data available to allow a proper assessment. Yet, ironically, it is the absence of such an assessment that the magnitude of economic costs of the road accidents is seldom appreciated so that resources have not been channelled to developing a better database for costing road accidents.

The objective of this paper is to provide some estimates of the overall cost of traffic accidents in Singapore.

2 Methodology

The estimation of the cost of traffic accidents involves two important steps: identification of the cost components and placing a monetary value on each of these components. It is obvious that the direct costs include as medical and care expenses incurred by the injured, replacement and repair costs due to property damage and other expenses, e.g. transportation costs. However in economic assessments as well as in insurance claims, costs arising from loss of earnings by those affected as well as compensation for pain and suffering are often included. There are also indirect costs associated with maintaining emergency and other essential services. Furthermore, there may be other social costs, for example, related to congestion and delays arising from the accident occurrence.

2.1 Methods of cost estimation

Placing a value on each of the cost component may not be straightforward as it depends on not only the availability of data but also the manner in which the estimates are derived. There are several approaches to estimate the costs. Hills and Jones-Lee [11] have discussed the following six methods for evaluating the cost of fatal accidents. These are: the "Gross Output" method, "Net Output" method, "Life Insurance" method, "Court Award" method, "Implicit Public Sector Valuation" method and the "Willingness to Pay" method.

The “Gross Output” or “Human Capital” method is based on the assessment of economic consequences, usually supplemented by a notional sum to reflect pain, grief and suffering of the victims and their family members. In contrast, the “Net Output” method deducts the future consumption of individuals killed in the accidents, reflecting a more conservative economic cost to the society. The “Life Insurance” method measures the valuation of risk associated with the road usage and is determined by the premiums which the driver population is willing to pay. The “Court Award” method is based on the actual compensation settlements awarded, which may be influenced by the degree of negligence found. In the “Implicit Public Sector Valuation” method, a set of implicit values, are used to value human lives. The “Willingness-to-Pay” method estimates the amount of money people affected would pay to avoid an accident.

The various methods of costing are built on very different premises and thus result in vastly different cost figures. The choice of the method depends on the purpose of the costing exercise. In developing a suitable methodology to estimate road accident costs for the purpose of maximising national output as well as social benefits, Jacobs [12] have evaluated these methods and proposed that only the Gross Output and the Willingness-to-Pay methods are most appropriate. The Willingness-to-Pay method is considered the better approach for conventional cost-benefit analyses and the most efficient way of allocating scarce financial resources. However, where relevant data to produce reliable Willingness-to-Pay estimates may be lacking, Jacobs [12] has recommended the Gross Output method instead. In this initial attempt to estimate the cost of road accidents in Singapore, the more conservative Gross Output method is adopted.

2.2. Gross output method

The basis of the Gross Output method is the concept of a statistical life, whose value is considered to be the output that an individual can produce over the period of their productive life [13]. Based on this argument, the cost of an accident will then be the loss of output or the output forgone by the economy as a result of the accident. In general, the productivity of any casualty is assumed to be equal to the average in the economy. The overall cost to the national economy is then the accumulated lost output obtained.

This approach views each person as a unique and valuable economic entity. Its main strength is that it provides an objective means of arriving at an estimate. Data values are generally measurable and the method is also useful in providing an estimate of the cost to society of a casualty over and above the private cost.

However, the methodology ignores the value of leisure and only considers work performed. As a result, it places no value on the emotional content of life. Hence the methodology generally produces estimates well below those obtained by other means [4]. It is possible to supplement the estimates with a component of subjective costs including pain, grief and suffering.

The conservative approach is recommended as it ensures an indisputable minimum value obtained for road accident costs in a country. The argument is that if the investment can be justified on such a minimum value, it will certainly be justified on any other value [14].

The cost components in the Gross Output method can be divided into two categories: those involving current resources which are consumed or diverted because of the accidents and those due to loss of future output. In the latter, the loss of output may be due to absence from work resulting from medical leave or reduction of potential productive output arising from long-term or permanent disabilities as well as death. The former includes costs associated with medical and rehabilitation treatment, damage to property, administrative, professional and emergency services.

For this study, the analysis was made for the year 1999, and all data and considerations are consistent for that year. As it is impossible to trace the cost incurred in every accident record, the cost assessment is done on an aggregated scale, typically according to the classification of accident severity. In Singapore, accidents are classified into four severity categories: fatal, serious injury, slight injury and property-damage only. A fatal casualty in a road accident is one in which the victim dies within 30 days of the accident. A seriously-injured casualty is one who has suffered injuries such as fracture, concussion, internal lesions, crushing, severe cuts and laceration or severe general shock requiring medical treatment or hospitalisation such that the person is unable to perform his ordinary pursuits for at least 7 days. A slightly-injured casualty is one who is conveyed to hospital from the scene in an ambulance or otherwise, one who requires subsequent medical treatment entailing hospitalisation and medical leave of no less than 3 days. Accidents are assigned the severity group according to the most seriously affected casualty in the accident. All reported accidents not involving injuries are classified as property-damage only accidents.

To ascertain the correct cost values, the cost components are evaluated in two groups: casualty-related (in which case the unit cost is for each casualty), and accident-related (in which case the unit cost is for each accident). Costs due to lost output and medical expenses as well as pain, grief and suffering are associated with each casualty involved in the accident while property damage and administration costs are more likely to be accident-related.

3 Cost estimates

3.1 Medical costs

Medical costs resulting from accidents cover a large number of items associated with the medical attention disbursed. First, victims may be given first aid and treatment and incur costs associated with the ambulance service. In the more serious cases, victims require immediate hospital treatment at the accident and

emergency services and may involve further non-hospital and outpatient treatment. Where a victim is hospitalised, the costs will increase due to hospital occupancy charges and the need for in-patient medical care, surgeon and specialist services as well as nursing care and in many instances, follow-up care and further outpatient services. There may also be costs associated with the use of aids and appliances to facilitate patient movement and rehabilitation. When an accident victim dies instantly at the accident scene or shortly after the accident, the medical costs is usually lower. However, those that die after admission into hospital will incur costs associated with emergency and intensive services, including special room charges and medication.

Clearly medical costs vary widely depending on the nature and the severity of the injury which is translated into duration of hospitalisation and rehabilitation. There are also different classes of hospitals and wards offering services to accident victims. Some hospitals handle specific cases, for example, the KK Women's and Children's Hospital treats only child and woman victims. For the purpose of the analysis, the Singapore General Hospital, being the largest public hospital and handling all types accident treatment, was approached to provide information on the direct cost of medical services offered for road traffic accident (RTA) victims. As no official data on the cost of treating RTA patients are recorded, a survey of RTA patients was undertaken by the Singapore General Hospital staff for those seen in the month of March 2001. In this, various costs were itemised according to the 3 classes of victims treated.

For the fatal cases, the number of days in hospital before death and the associated costs for operation, medical check-up and specialist treatment such as X-rays, were noted. In the case of seriously-injured victims, information gathered include the itemised costs incurred at the Accident and Emergency Department, the number of days of hospitalisation, the number of medical check-ups and specialist treatment needed and all their estimated charges. Other information related to out-patient treatment like the number of follow-up appointments within the year, duration of medical leave granted and earning rate of patients were obtained. For slightly-injured victims, itemized costs at the Accident and Emergency Department, the duration of medical leave granted, the number of follow-up appointments and the associated charges were recorded.

Based on the consolidated computations, medical costs per fatality amounts to \$12,760 while that a seriously-injured and slightly-injured casualty is \$30,668 and \$4,656 respectively.

3.2. Lost output

Lost output refers to the contribution that accident victims have forgone due to injury or death. In the case of an injured victim, the economic loss is measured in terms of the loss in productivity throughout the period of incapacity. This is estimated by tracing records on the duration that the victims are hospitalised or given medical leave of absence from work. On the other hand, for each deceased

person resulting from the accident, there will be the loss of future production of the individual to the economy. This is clearly dependent on the age of the individual at point of death. As the duration is measured in years, the loss of income in future years will have to be adjusted to the present value. A discount rate of 4% is assumed in the study. This does not take into account the age-dependent effect of productivity as such information is not available.

In computing the economic rate of productivity for death victims, no weight is given to the different types of individuals involved, except for the consideration of their age. An average value is assumed, i.e., all victims are assumed as average workers capable of an economic production measured by the per capita Gross Domestic Product (GDP). This simple formulation obviates the often-raised problem of associating the economic value of life and injury with attributes such as race, profession and economic status. However, it does not deal with the objection of reducing life and its quality to just an economic value; an issue if dealt with will make no economic evaluation possible. For injured victims, the lost output is computed based on the average wage rate of patients obtained from the survey sampled at the Singapore General Hospital.

From the age distribution of fatal accident victims in 1999 (see Table 1), the average loss of productive years is computed based on a retirement age of 65. Projecting a GDP growth of 4.4% per annum and a discount rate of 4%, and a per capita GDP of \$35,969 in 1999, the lost output for an average fatal casualty was found to be \$1,063,450 at 1999 prices. Based on the lost output due to medical leave granted and the period of incapacity due to injuries sustained as well as the average wage rate sampled, the average lost output for a seriously-injured victim is \$47,578 while that of a slightly-injured victim is \$5,468.

Table 1: Age Distribution of Fatal Casualties

Age	Distribution of Fatalities (%)
< 15	2.51
15 to 20	7.54
20 to 25	18.59
25 to 30	11.56
30 to 35	10.05
35 to 40	8.54
40 to 45	5.03
45 to 50	6.03
50 to 55	4.52
55 to 60	2.51
> 60	23.12

3.3. Pain, grief and suffering

It has been shown [4] that victims and their family members suffer from psychological deteriorations following an accident. The computation of cost-

benefit analysis in many countries usually include a social cost component and for the case of accidents, a notional value of pain, grief and suffering is often included to reflect the society's and individual's aversion to death.

The cost associated with pain, grief and suffering is, by virtue of its character, rather subjective. This includes the physical and mental suffering of the victims, their relatives and friends. Furthermore, trauma and damage to the quality of life can also be included. Research undertaken to estimate this cost has gone along the line of correlating this cost component to resource costs which can be objectively measured. Currently there is little work done in Singapore, if any, to establish a reliable estimate of pain, grief and suffering associated with road accidents. To circumvent this lack of information, the correlation estimates adopted in United Kingdom [12] are assumed. In this, the cost of pain and suffering for each fatality is assumed to equate to 38% of the resource cost associated with a death from traffic accident. In the case of a seriously-injury victim, the pain and suffering is equivalent to 100% of the corresponding resource cost of one with serious injury while for a slightly-injured casualty, this is assumed to be 10% of the associated resource cost.

Based on these computations, the costs attributed to pain, grief and suffering is \$358,124 for each fatality, \$87,069 for each seriously-injured victim and \$1,779 for each slightly-injured casualty.

3.4 Cost of property damage costs

Almost all accidents result in some damage to the vehicles involved and in some cases, damage to public infrastructure such as lamp-posts, guard-rails, traffic signs and the road surface. The associated costs will include repairs and replacement of vehicle parts and infrastructure elements. Costs associated with property damage may also include car rental charges during the period the damaged vehicles are out of service.

The estimation of property damage can be ascertained through insurance records. There are however, practical difficulties in obtaining comprehensive figures. First, not all properties are insurable and hence may not be reflected in insurance claims. Moreover there are numerous unreported accidents for which no insurance claims were made. These claims usually involve small amounts. Furthermore, the amount of damage to property can vary considerably from one accident to another and this may not be correlated well with the degree of injury sustained in the accident. Hence it is difficult to assign different property damage costs for the different severity classes of accidents.

Using statistics from the General Insurance Association of Singapore, the total compensation for property damage from traffic accidents amounted to \$489.62 million. This translates to \$5,424 for each reported accident.

3.5 Administrative and emergency services

The occurrence of road accidents necessitates the services of the police to be present at the accident scene to attend to the victims and other road users as well as to input and maintain accident records and to carry out accident investigation. Accidents may also require emergency services from the ambulance and fire departments. Where claims are involved and disputes brought to the courts, insurance and legal services and other professional services may be engaged. These involve administration costs as it may be argued that if not for these accidents, the resources can be deployed elsewhere.

The administrative cost of the police is determined by eliminating the expenditure associated with specific departments which may be redundant if not for the occurrence of accidents. These departments include the camera unit, the accident investigation unit and the accident research unit. In estimating other costs, the proportion of time spent by police officers in attending to accident cases, both on site and at the stations and the average wage rate is needed. The administrative costs estimated by the Traffic Police amount to \$6.7 million in 1999. Based on estimates made by the Singapore Civil Defence Force, the costs of ambulance services for road accidents totalled \$0.898 million, giving an average of \$288 per ambulance run. The administrative costs incurred for insurance services were estimated using operating expenditures reported by the General Insurance Association of Singapore, the body which maintains records of accident claims. The total administrative costs for insurance amounted to \$48.8 million in 1999. There are however, no easy and reliable records of expenditure associated with the legal service in traffic accident cases. This component is therefore not computed in the overall administrative cost.

Based on the data obtained, administrative costs is \$22,044 for a fatal accident, \$3,425 for one involving serious injuries and \$2,278 for the case of slight injuries and \$445 for the case of no injuries.

3.6 Overall accident costs

The individual cost components in each accident and casualty category are summarised in Table 2. If the crude estimates of pain, grief and suffering are included in the computation, the human costs total about \$1.273 million for a fatal casualty, \$165,000 for a seriously-injured casualty and nearly \$12,000 for a slightly-injured casualty. The other cost, on a per accident basis, is a little more than \$27,000 per fatal accident and nearly \$9,000 per accident involving serious injuries. For the case of an accident involving slight or no injuries, this will be almost \$8,000 and \$6,000 respectively. Taking into account the possibility of multiple casualties in an injury accident, the overall cost per accident occurrence (for all injury levels) is \$10,700. In total, the average cost per fatal accident is \$1.368 million, serious-injury accident, \$199,000, slight-injury accident, \$25,000 and property-damage accident, \$6,000.

Table 2: Summary of costs per casualty or per accident (\$)

	Fatal	Serious Injury	Slight Injury	Property Damage only
Per Casualty				
Lost Output	902,362	47,578	5,468	-
Medical costs	12,760	30,668	4,656	-
Pain, Grief, Sufferings	358,124	87,069	1,779	-
Total	1,273,246	165,315	11,903	0
Per Accident				
Administrative Cost	22,044	3,425	2,278	445
Property Damage	5,424	5,424	5,424	5,424
Total	27,468	8,849	7,702	5,869

In 1999, there were 189 cases of fatal accidents resulting in 199 fatalities. There were also 343 accidents involving serious injuries and 6,018 involving slight injuries. More than 83,000 cases of damage-only accidents were reported. As shown in Table 3, the total cost of traffic accidents occurring in 1999 is \$966.23 million, of which about half are attributable to damage only accidents and a little more 27% due to fatal accidents. Based on a 1999 GDP value of \$142.1 billion, the cost of accident is about 0.68% of the GDP. This may appear low in comparison to many international estimates [9], particularly with the more developed countries. However, considering that the approach using Gross Output method is conservative and that several cost components such as legal administrative costs have not been computed and that non-reported accidents are excluded, these estimates can be regarded as lower bound values.

Table 3: Total cost of accidents

Accident Type	Overall costs (\$ million)
Fatal	258.567
Serious Injury	68.334
Slight Injury	147.954
Property Damage Only	491.376
Total	966.233

4 Conclusion

In comparison to other countries in the region, Singapore has a relatively efficient and safe road network and has a good road safety record. The accident rates, especially in terms of fatal cases, are still unacceptably high by the standards of developed countries.

This paper has shown that the costs of accidents in Singapore are high, even when conservatively estimated. In 1999, the annual costs of accidents amounted to nearly \$1 billion representing nearly 0.7% of the GDP. Given this high cost, it is



necessary that the authorities should invest more into road safety research to better understand the causes of road accidents as well as in road safety programs to improve the road environment

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