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ECONOMIC COST OF HUMAN FATALITIES DUE TO ROAD TRAFFIC ACCIDENTS IN SRI LANKA: AN ESTIMATION BASED ON THE HUMAN CAPITAL APPROACH

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ABSTRACT

Though a key factor behind the economic growth of a nation, transportation is associated with negative externalities that directly affect the economic performance of a country: road traffic accidents being one such negative externality. An increase in the number of accidents and related fatalities poses a socio-economic burden to developed and developing countries alike. Hence, quantifying the impact of road traffic fatalities on the national economy has become a popular topic amongst researchers in transportation.

The present study was an attempt to quantify the economic burden of premature mortalities associated with road traffic accidents in Sri Lanka, using descriptive analytical tools and employing the Human Capital Approach, upon estimating the Years of Life Lost, an integral component of Disability-adjusted Life Years.

The outcomes revealed that road traffic accidents have been a growing threat in Sri Lanka, and that, despite the decreasing number of accidents, fatalities associated with road traffic accidents have increased: this reflects a trend of increasing accident severity. The results also allowed for an estimation of the human capital-related economic cost of fatalities due to road traffic accidents. This was found to be nearly 0.25% of the GDP of the corresponding years: exceeding the capital expenditure of the Government in the health sector and more than half that in the education sector.

Keywords: *Road Traffic Accidents, Fatalities, Disability, Years of Life Lost, Human Capital Approach of Economic Valuation, Sri Lanka*

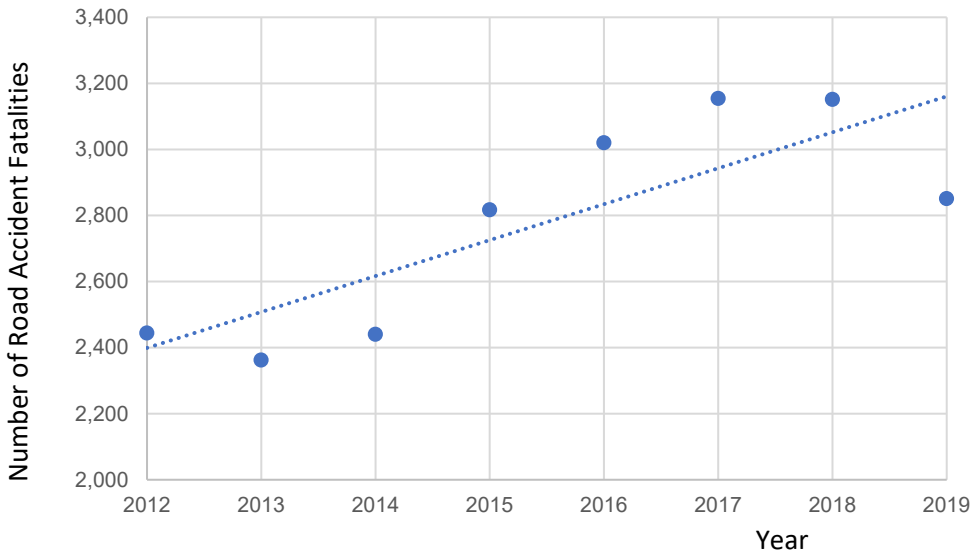
1. INTRODUCTION

Throughout history, mobility has been essential to humans; thus, modes of transport have existed as far back as the ancient river valley civilisations. The development of transportation was vital to the rapid economic growth of European countries during the late 19th and early 20th centuries. However, the mass production of motor vehicles and the rapid increase in the demand for motorised mobility has given rise to many social, environmental, and economic ill-effects, including congestion, accidents, and air pollution.

According to the World Health Organisation (WHO), Road traffic injuries are the eighth leading cause of death in all age groups, and more people are now killed in road traffic accidents than from HIV/AIDS, Tuberculosis, or diarrhoeal diseases. Road traffic accidents are also the leading cause of death among children and young adults aged 5–29 years [1]. Researchers have found that weak road conditions, driver indiscipline and lack of knowledge, weather conditions, condition of vehicles, fatigue, and stress, driving under the influence of alcohol, speeding, failure to respect rights of way, failure to fulfil civic responsibilities, and also the overall level of economic and social development determine the number of road accidents in a country [2].

Figure 1 depicts the evolution of accident fatalities in Sri Lanka from 2012 to 2019.

Figure 1: Evolution of traffic accident-related deaths from 2012 to 2019



Source: Road accident data records of the Sri Lanka Police.

The increase in the number of fatalities from 2,444 in 2012 to 3,154 by 2017 reflects nearly a 30% increase over four years and an average annual growth of around 5%.

A decrease, however, could be observed in 2019.[1] This scale of the number of deaths owing to traffic accidents would inevitably amount to substantial socio-economic costs; among these, productive life years lost is noteworthy, because such fatalities deprive the economy of the value such human resources would otherwise add.

2. OBJECTIVES OF THE STUDY

It is evident, given the above, that road traffic accidents have become a socio-economic burden, resulting in costs across several dimensions, including damage to property, injuries, hospitalisation and medication expenditure, administrative expenses such as policing, time and energy wasted in congestion, and also death. Lives lost due to road accidents are arguably the costliest of all accident-related costs incurred by the national economy, due to their potentially ramified implications, such as loss of productive human capital, which could otherwise be productively employed in the labour force and loss of family breadwinners, thus impoverishing families. Loss of young lives, referred to as "premature fatalities", is of particular significance because of its adverse impact on the national economy through the deprivation of such human capital over a longer period.

It was this perception that encouraged the present study to focus on traffic accident fatalities and associated costs, which had not hitherto been adequately explored, particularly in the Sri Lankan context. The present research was therefore undertaken with the specific objective of estimating human life years lost due to premature deaths caused by road traffic accidents in Sri Lanka, and their value in monetary terms, given the gravity of the problem and drawing possible policy-relevant inferences.

3. LITERATURE REVIEW

Though transportation makes a significant contribution to economic development by making factors and produce more mobile, the expansion of motorised transportation also has given rise to significant negative externalities; road traffic accidents being one such severe ill-effects, both at national and international levels. The World Health Organisation (WHO), for instance, has reported that the problem of road traffic accidents prevailed not only in developing countries but also in developed Europe [3]. However, the economic impact of road traffic accidents would be considered particularly significant in low and middle-income countries, which frequently struggle with other developmental needs. As forecast in the "Global Status Report:

[1] The low-profiled festivities on Wesak, Poson and Esala and related reduction of vehicular mobility in the aftermath of Easter Sunday attacks could be hypothesised as a possible reason behind this reduction in 2019; a separate research fathoming into causes, however, being required to examine such a hypothesis.

Time for Action" [4], deaths due to road traffic accidents will become the fifth most prominent cause of death by 2030, with an estimated 2.4 million fatalities in that year. Apart from that, the World Health Organisation has identified that the number of deaths in low and middle-income countries is three times higher than in upper-income countries; 91% of the world's road traffic fatalities occur in low-income and middle-income countries which have only 48% of total vehicle registrations. Further, as per Pan-American Health Organisation, the cost of road traffic fatalities in developing countries has been estimated to be around USD 100 Billion, almost twice the amount of development aid received by those countries [5].

Therefore, WHO has emphasised the importance of Governments taking necessary steps to identify the most vulnerable road users, types of vehicles, as well as high-risk roads to formulate policies to minimise accidents and associated costs of accidents. It is due to this severity of the problem of road traffic accidents and their scale that Sustainable Development Goal 3.6 under "Good Health and Wellbeing" has focused on the importance of minimising deaths occurring due to road traffic accidents.

Identifying the most vulnerable type of vehicle, gender, and age cohorts becomes a prerequisite for analysing the economic impacts of road traffic accidents. In Sri Lanka, much research on road traffic accidents has already been conducted using several different methodologies. Bhavan (2018), for instance, has researched annual time series data extracted from various sources, using ARDL bound test approach to study the relationship between per capita GDP and road accidents in Sri Lanka [6]. His study has examined whether the Kuznets relationship exists between per capita GDP and road accidents and inferred that there appeared to be an inverted U-shaped relationship between per capita GDP and the number of road accidents in Sri Lanka. In addition, his findings also revealed that the urban population in the age cohort of 30-39 years would be the highest affected by road accidents.

Kumarage & Jayaratne, having conducted research using traffic accident data in Sri Lanka, have found that in 2005, light vehicles were frequently involved in traffic accidents; motorcycles being the type that accounted for the highest number of fatalities in a given year [7]. In a further extension to their research, they also have found in 2006 that pedestrians were among the most vulnerable to road traffic fatalities in Sri Lanka; 95% of pedestrian deaths were caused due to the faults of motorists [8].

Analysis of the literature paved the way to identifying that young adults would be the most vulnerable to accident fatalities. Amarasinghe and Dharmaratne (2019), for instance, examined the epistemology of road traffic crashes reported in the Kurunegala Police Division in Sri Lanka from April to December 2013, focusing on

the identification of vulnerable age groups and genders, as well as the times at which crashes were more likely [2]. According to their findings, 851 road traffic accidents had been reported during the study period, with 1,481 vehicles and 1,887 road users being involved; 7.8% of those had been fatal, 70% had resulted in non-fatal injuries, whilst 22.2% had caused only property damage. The average rate of road traffic accidents reported had been around three per day; the majority (37.3%) were reported from urban areas in Kurunegala between 12.00 hrs-17.59 hrs. Road traffic accident fatalities had been higher between 0.00 hrs-05.59 hrs in rural areas. The leading type of vehicle involved had been the motorcycle, while males aged 31-40 years were found to be the most vulnerable to traffic accidents, representing 84% of the reported cases. Jeepara and Pirasath (2011) also concluded that males aged 19-40 years were more vulnerable to road traffic accidents and identified motorcycles as the vehicle type with the highest risk of fatalities in Sri Lanka [9].

Estimating the economic cost of road traffic accidents and their consequences is a complex task. Accidents have diverse effects on lives and property, and their social and economic implications are often far greater than the visible impacts of the road traffic accidents themselves, as found in the literature [10], [11]. Atubi (2017), for instance, identified several interrelated economic and social consequences of road traffic accidents, such as (i) loss of family income sources due to the death of breadwinners, (ii) depletion of the economic prospects of affected families, and (iii) loss of productive man-hours. Quantifying these impacts becomes a necessary precondition to understanding the magnitude of costs involved [12]. Premature mortalities due to road traffic accidents entail deprivation of the economic value addition that would have occurred during the remaining life years of the deceased. This is because, if not for the fatal accident the victims have faced, they could have contributed to the economy as members of the labour force.

Despite this complexity and diversity, several studies have attempted to evaluate the economic impact of accidents during the last three decades [13]. The Human Capital (HC) method and the Willingness to Pay (WTP) approach appear to have been widely used to estimate the cost of road traffic accidents. Elvik (2000), for instance, has used HC and WTP approaches to quantify the cost of road traffic accidents in selected European countries and found that the cost of road traffic accidents in the UK, Sweden, Norway, and Iceland was 2.1%, 2.7%, 2.3%, 3.4% of the GDP, respectively [14]. Mohan (2002) also found out that the cost of road traffic accidents in India was around 2% of the country's GDP [13].

According to estimates by the World Health Organisation (WHO), deaths and disabilities due to road traffic accidents amount to around 2% of a country's Gross Domestic Product, corresponding to around 127,000 people being killed and about

2.4 million injured every year [15]. The Global Road Safety Program of the World Bank, in 2018, concluded that the cost of road traffic accidents exceeding 1% of the GDP is “unacceptable” [1].

Regarding estimating the cost of road traffic accidents in Sri Lanka, the study conducted by Kumarage et al., in 1999, appears to be a pioneering attempt [16]. They estimated the overall cost of fatal accidents in 1998, including loss of output, property damage, medical expenses, police cost, insurance cost, and congestion cost, to be nearly Rs 2.9 billion (in 1999 rupee values), and the specific cost per fatal accident to be Rs 1.5 million. It is noteworthy that loss of output accounted for 78% of the costs relating to a fatal accident estimated in their study; an indication of the relative scale of the economic cost associated with loss of productive life years caused by traffic accident-related premature mortalities. Their estimate of the total cost of all categories of accidents (including fatal and non-fatal accidents) in 1998 was Rs 6.2 billion.

The research conducted by Ratnayaka and Jayasinghe in 2001 used the Life Insurance methodology, summing up all costs involved in road accidents, such as loss of output, police costs, hospital costs, etc., and has arrived at an estimate that the total cost of all traffic accidents in Sri Lanka amounted to be Rs. 5.1 billion in the year 1996 and Rs. 8.1 billion in the year 1999, accounting for about 1 % of the country’s GDP [17].

Perera, in 2016, adopted the Human Capital (HC) approach in an attempt to estimate the cost of road traffic accidents in Sri Lanka. He has found that the loss of production owing to life lost due to road traffic accidents had been over Rs 100 billion between 1977 and 2007 [18]. He also found that one person was killed every 4.5 hours owing to a road accident in Sri Lanka in 2007, while the road traffic crashes in Sri Lanka have increased by 249% between 2007 and 2017.

Even though many studies had already been conducted to estimate the economic costs of road traffic accidents, WHO (2009) opined that the cost of road traffic accidents had not been adequately explored, particularly from the angle of valuing productive life years lost owing to premature deaths or disabilities, to encourage policymakers to implement policies to minimise road traffic accidents [4]. Therefore, professionals in transport and health economics have developed several methods to quantify the impact on human lives resulting from road traffic accidents. ‘Disability Adjuster Life Years' (DALYs), a measure introduced in 1996 to quantify the cost of premature mortalities and disabilities, for instance, is frequently used by researchers, including Murray and Lopez, in estimating the cost of road traffic accidents [19], [20]. Quality-Adjusted Life Years (QALY), Disability-Adjusted Life Expectancy (DALE), and Healthy Life Years (HEALY) are other methodological parameters and measures

developed to reflect accident impacts while overcoming difficulties associated with the complexity of estimating the cost of impact on human lives.

The present research was an attempt to bridge the gap prevailing due to the lack of contemporary studies to quantify economic losses associated with productive human years lost to road traffic fatalities in Sri Lanka. The findings of Ratnayaka and Jayasinghe (2001), on one hand, have not focused on that particular aspect, and, on the other hand, have used traditional methods to estimate the costs [17]. The cost estimates made by Kumarage et al., for the year 1998, appeared significantly lower than what Ratnayaka and Jayasinghe estimated for the year 1999. Perera (2016), though estimating based on the Human Capital approach, has not considered their age-wise differences [18]; an important dimension to examine owing to the direct relationship between the age of victims at the point of death and the corresponding productive life years lost. Moreover, the estimates made in all these studies were more than a decade old and needed to be updated. This was because any estimate made about the economic impacts of premature mortalities due to road traffic accidents should be calculated on an annual basis for such cost estimates to be as relevant as possible for use in policy-making and strategic planning. The use of estimates made a long time ago would inevitably underestimate the current cost of fatalities [21].

4. METHODOLOGY

4.1. Approach

This study focused on quantifying the economic cost associated with the loss of productive life years due to premature mortalities resulting from road traffic accidents in Sri Lanka. The economic burden of premature mortalities due to road traffic accidents was calculated based on the summation of such individual life years lost due to accident-related deaths, which otherwise could have contributed to the national economy. The value of "Years of Lives Lost" (YLL) was thus used as the measure of quantification of the cost of premature mortalities.

4.2. Conceptualisation and Framework

YLL was conceptualised by the GBD study as a time-based indicator to measure the value of life years lost due to premature mortalities [20]. YLL is an integral component of the "Disability-Adjusted Life Years" (DALYs), and an estimate that focuses on the cost of fatalities, in terms of productive life years lost.

Therefore, YLL considers the difference between the age of death and standard life expectancy, because of estimating the loss of years due to premature mortality. For example, a female child who dies owing to a road traffic accident at the age of 5 would lose 73.6 years of her life, when she would be expected to live until 78.6 years

of age [2], if not for the accident. In effect, the YLL quantifies the actual burden of this premature mortality (which is required to calculate DALYs).

DALY, on the other hand, is a summary measure of people's health that combines years of life lost due to premature death and years of life lived in states of less-than-optimal health, loosely referred to as "disability", of specified severity and duration [22], [23]. One DALY equals one lost year of a healthy life. DALYs have been used by most countries as their health metric to quantify premature mortalities. Premature death occurs before the age to which a dying person could have expected to live if he/she were a member of the standardised model population with a life expectancy at birth, and therefore, the DALY is a health gap measure that combines both human times lost due to premature mortality and non-fatal conditions. The loss of healthy life due to a non-fatal condition requires an estimation of the incidence of the injury.

DALYs consist of two components that measure years of life lost due to premature mortalities as well as years of living with a disability. The basic equation for the calculation of DALYs, introduced by Murray & Lopez (1996), is as follows [24]:

Disability-Adjusted Life Years = Years of Life Lost + Years Living with a Disability

$DALY(c,a,s) = YLL(c,a,s) + YLD(c,a,s)$

For given cause c, age a, and sex s,

$YLL(c,a,s) = N(c,a,s) \times L(a,s)$

Where,

N(c, a,s) is the number of deaths due to cause c for given age a and sex s.

L(a,s) is the standard loss function in years for age 'a' and sex 's'. The loss function is specified in terms of the life expectancies at various ages in the standard life table.

$YLD(c,a,s) = I(c,a,s) \times DW(c,a,s) \times L(c,a,s)$

Where,

I(c,a,s) is the number of incident cases for cause c, age a, and sex s;

DW(c,a,s) is the disability weight for cause c, age a, and sex s, the factor that reflects the severity of the disease on a scale from 0 (perfect health) to 1 (equivalent to death).

L(c,a,s) is the average duration of disability in years until remission or death.

[2] Based on the standard life expectancy estimate made by the Department of Census and Statistics, Sri Lanka

As mentioned above, this research opted to limit its estimations to value premature mortalities due to road traffic accidents, and thus, the "disability" concept was not focused on. The main reason for this narrowing down was the non-availability of data on disabilities caused by accidents and their gravity, calculating the cost of disability was practically impossible.

Therefore, the model used for the present analysis was confined to estimating the cost of loss of life (YLL).

4.3. Model for estimating YLLs

The concept of DALYs is based on discounting health with time, which implies that society prefers to have a healthy year earlier than later in the future.

Equation (1) below would estimate YLL for a given number of deaths, standard life expectancy, and a given level of discount rate [23], [25].[3]

$$YLL = \frac{N}{r}(1 - e^{-rL}) \quad \text{---------- (1)}$$

where,

N = the number of deaths.

L = standard life expectancy at age of death (years).

r = discount rate (e.g. R=0.03 corresponds to a discount rate of 3% per year).

When age weighting and discounting are applied, and the years between the event and the life expectancy are summed up, the initially simple formulae for YLL become more complicated [20]; the formula for a single death is expressed in Equation (2).

$$YLL = \frac{KCe^{ra}}{(r+\beta)^2}\left[e^{-(r+\beta)(L+a)}[-(r+\beta)(L+a)-1] - e^{-(r+\beta)a}[-(r+\beta)a-1]\right] + \frac{1-K}{r}(1 - e^{-rL}) \quad \text{----------(2)}$$

where:

a = Age of death (years)

r = Discount rate (usually 3%)

β = Age weighting constant (e.g. β =0.04)

K = Age-weighting modulation constant (e.g. K=0)

C = Adjustment constant for age-weights (e.g. C=0.1658)

L = standard life expectancy at age of death (years)

[3] Jamison et al. (2006) identified that models of DALY estimations commonly used the 3% discount rate with zero-age weighting in calculating both YLLs and YLDs [25].

Total YLL for a particular year can be derived by summing YLLs derived for a specific age group. This model has been used in GBD studies to calculate the YLL from 2000 to date [23]. In the present study, the same model was employed to quantify the cost of premature mortalities in Sri Lanka, while "R" statistical software and Microsoft Excel computations were used to make calculations.

4.4. Loss in Monetary Values

YLL only focuses on the loss of healthy life that a person might have enjoyed if not for premature mortality, and thus, YLL does not assign monetary values to premature mortality; a significant limitation of the indicator.

To circumvent this limitation, the present research adopted the "Human Capital approach" to convert the loss of years into financial terms. In that approach, the per-capita Gross Domestic Product, which reflects the average contribution of a person to the economy within a year, is used as a proxy to estimate in monetary terms the value of a human year of economic output.

It may be pertinent, however, to recognise at this point that there is a controversy, as raised by Hauer (1994), on the ethics of valuing human life in monetary terms [26]. Nevertheless, much research has valued human life, and one may even say that society does it implicitly, particularly in the assessment of the need for life insurance. Besides, such valuation becomes unavoidable to show the cost to society of this sort of externality. Therefore, this study opted to monetarily estimate the value of human life, for a better understanding of the economic implications of road traffic accidents.

Accordingly, the number of years of life lost (YLL) owing to traffic accidents in a particular year, calculated using the YLL model, was applied to the average economic value of a human year estimated based on the above-described "Human Capital approach", to arrive at the total economic cost of life years lost, in present value terms, owing to accidents that occurred in the year under consideration.

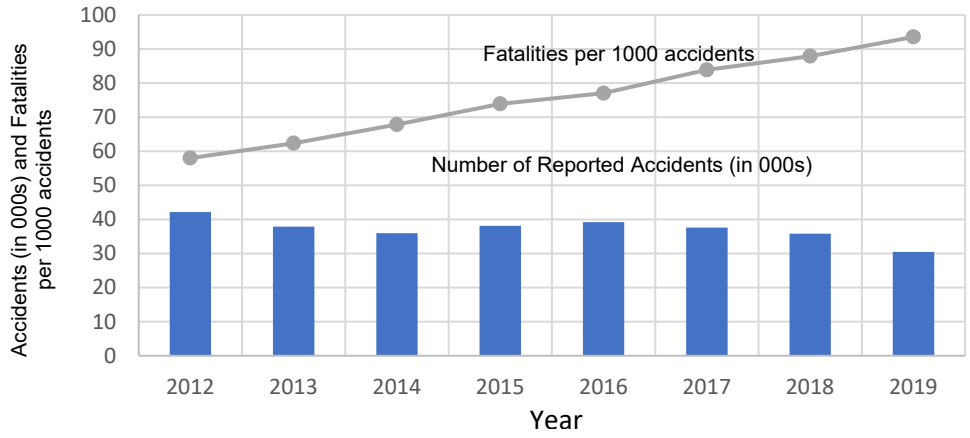
4.5. Sources of data for the analysis

This analysis was based on secondary data on road traffic accidents in Sri Lanka, sourced from Sri Lanka Traffic Police Headquarters, the Annual Performance Reports of the Sri Lanka Police, Department of Motor Traffic of Sri Lanka, Ministry of Health as well as the Department of Census and Statistics of Sri Lanka.

5. RESULTS AND DISCUSSION

At the outset, the relationship between the number of fatalities and the number of accidents from 2012 to 2019 was subject to analysis. The results are depicted in Figure 2.

Figure 2: Accidents and Fatality Intensity - Evolution between 2012 and 2019



Source: Authors' estimates based on data published by Sri Lanka Police

These results revealed that, in Sri Lanka, fatalities due to road traffic accidents have increased amidst a declining trend in the number of reported accidents. It reflects a trend of continuously increasing *fatality intensity* in accidents reported during the period of study (from 58 fatalities per every 1,000 accidents reported in 2012 to 93.5 by 2019); an important revelation that points to a gradual increase of "severity" of accidents and the "gravity" of their impacts.

The accident severity indicates the possibility that the economy incurs significant economic costs, including loss of productive lives, property damage, healthcare burden, and administrative expenses. Estimating such costs would be conducive to the justification of strategic interventions to minimise traffic accidents, but, the present research focused only on estimating the cost of life years lost to traffic accidents. This objective was met in two stages; firstly, the Years of Life Lost (YLLs) were estimated, and secondly, those were valued.

Years of Life Lost (YLL) due to premature mortality that occurred in Sri Lanka owing to traffic accidents during the period from 2016 and 2019 were computed using the model described by Equation (2). YLL was thus calculated by substituting the relevant demographic and statistical values for the parameters therein, which were used to estimate the loss of productive years of life due to non-communicable diseases by the World Health Organisation for their Global Burden of Disease calculations [27].

Table 1 summarises the estimated annual loss of years (YLL) due to road traffic accidents. Accordingly, the years of life lost due to traffic accidents would have amounted to 58,047 in 2016, which would have increased to 60,208 in 2017, but reduced to 60,007 and 53,765 in 2018 and 2019, respectively.

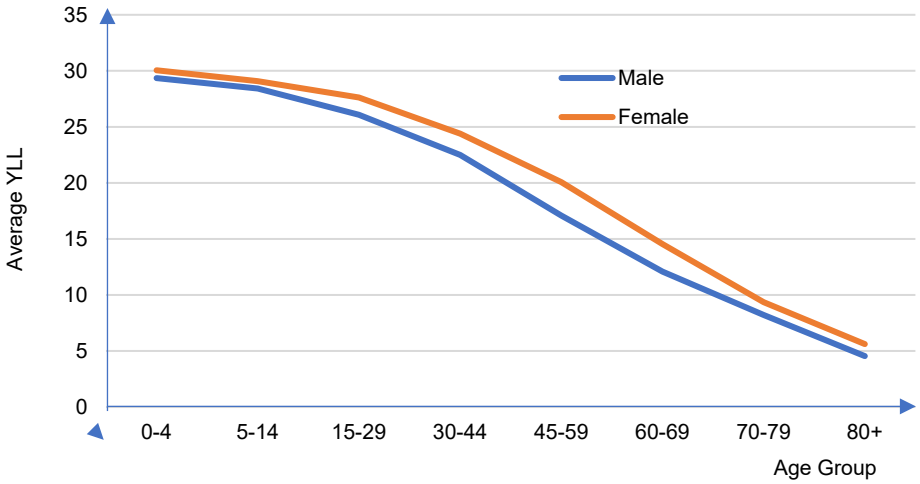
Table 1: Summary of YLL Estimates (2016-2019)

Year	K=0 r = 3%		
	Male YLL	Female YLL	Total YLL
2016	49615	8432	58047
2017	49832	10375	60208
2018	50213	9793	60007
2019	44757	9007	53765

Source: Authors' estimates

Further, the age and gender-specific YLL values could also be computed as depicted in Figure 3, which reflects the patterns and relative significance of the impact of fatalities in the two gender groups and different age cohorts.

Figure 3: Average YLL based on Age and Gender



Source: Authors' estimates

The above results indicate that the average YLL of younger victims is much higher than those of relatively aged persons, reflecting that a higher number of younger persons have died owing to traffic accidents in Sri Lanka than older people. This is likely to be a result of greater exposure of economically active younger persons to road accidents compared with older persons whose road-based travelling may be relatively less frequent.

Estimated YLL values were thereafter converted into monetary terms using the Human Capital approach, as the next step. The relevant input data on standard life expectancy in Sri Lanka, age and gender-specific population statistics, per-capita GDP of the country, and the exchange rates, corresponding to the period from 2016

to 2019, were fetched from publications made by the relevant official sources, including the Central Bank of Sri Lanka and the Department of Census and Statistics. Data on traffic accident fatalities corresponding to the same period were sourced from the reports published by the Department of Police.

According to the results summarised in Table 2, road traffic accidents that occurred in Sri Lanka in 2016 would have caused a YLL-related cost of USD 226 million in present value (2016) terms (at a 3% discount rate). The results also indicated that the cost of YLLs to the economy increased up to USD 245 million by 2017 and remained the same in 2018; but has decreased to USD 207 million by 2019.

Table 2: The Cost of Road Traffic Fatalities from 2016 to 2019

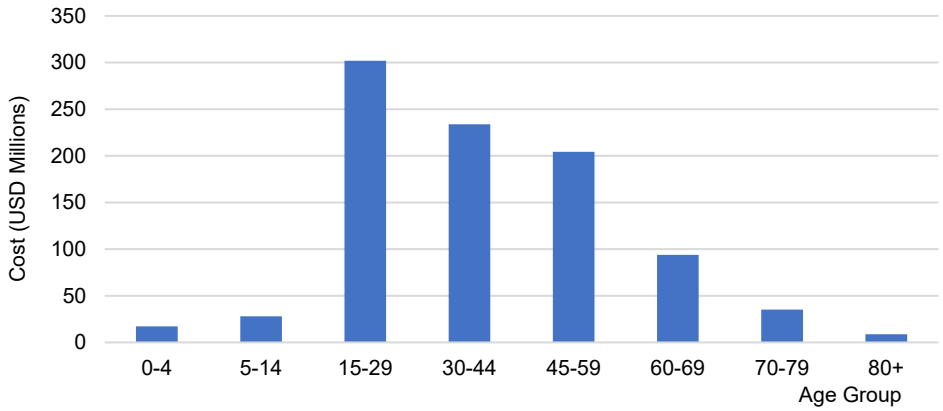
Year	Cost		Cost as a % of GDP
	(USD Mn)	(Rs Mn)	
2016	226	32 843	0.27%
2017	245	37 409	0.28%
2018	245	39 794	0.28%
2019	207	37019	0.25%

Source: Author estimations

These results revealed that the Sri Lankan economy would have lost between 0.25% to 0.28% of GDP on account of human years lost due to traffic fatalities during the period under consideration.

Apart from analysing overall economic cost, this study also examined the age cohort-based economic burden due to premature deaths caused by road traffic fatalities, the results of which exercise are depicted in Figure 4.

Figure 4: Age-based Distribution of Total YLL-related Costs (2016-2019)

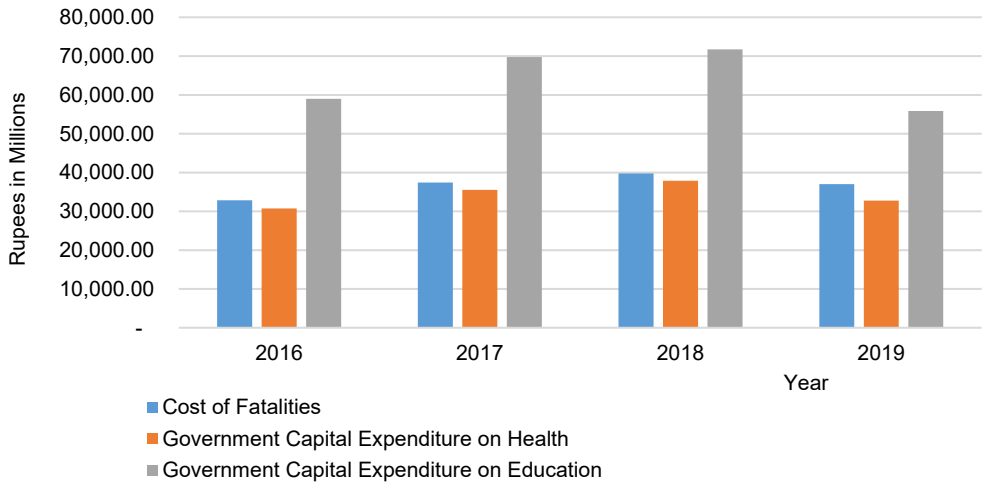


Source: Authors' estimates

It is evident from the above analysis that, during the period of this study, the highest cost due to traffic fatalities have been associated with the age group between 15 to 29 years, which would have been approximately USD 300 million. The age groups between 30 to 44 years as well as between 45 to 59 years also appeared as victims of traffic fatalities with significantly high YLL-based costs. On the contrary, the impacts on the age groups younger than 14 years have been much less, possibly owing to lesser exposure to accidents, even though the life years lost, if a death occurred at such a young age, would be much greater than such occurred in older ages. The YLL-based economic costs of traffic fatalities in the age groups above 70 years also were much less, compared to those economically active age groups; both lesser exposure to accidents and the shorter remaining years of life would have been the likely reasons behind this outcome.

The study also went into comparing the Human Capital-based cost of years of life lost due to traffic fatalities against the Government capital expenditure on the Health and Education sectors in Sri Lanka corresponding to the period of study. The results are graphically depicted in Figure 5.

Figure 5: Comparison of Cost of Fatalities with Capital Expenditure on Health and Education (2016-2019)



Source: Authors' estimates and published data by CBSL - 2016, 2017, 2018 and 2019 [28]

A glance at these cost estimates enables several important inferences. Firstly, it is clear through the comparative results that the annual cost of road traffic fatalities, in terms of YLL alone, is greater than the annual capital expenditure incurred by the Government on the Health Sector during the period, and more than half the Government's annual capital spending on Education; the economic significance of the cost of traffic fatalities is thus mirrored, reflecting the necessity of prioritised

policy intervention in this regard. Secondly, it is pertinent to perceive that loss of productivity is not the sole cost dimension related to road traffic casualties. There are other direct and indirect costs associated with road traffic fatalities, such as the cost of medical treatment, the cost of damage to property, the cost to Police, administrative costs, etc. Therefore, the cost estimates figuring between Rs 32 billion to 40 billion during the period from 2016 to 2019 that was yielded through the present research, which did not cover such "other cost elements", but only the loss of productive human life years due to road traffic accidents, have to be perceived as underestimates of the overall cost of road traffic accidents. Thus, it could be concluded that the overall cost of accidents that would have been incurred by the socio-economy annually during the study period would have been much greater and economically more significant. Thirdly, the mere YLL-based cost estimates made in the present study, if compared with the cost estimate of Rs 8.1 billion in the year 1999 by Ratnayake & Jayasinghe (2001), reflects a rapid escalation of negative economic impacts of road traffic accidents in Sri Lanka, amounting to an average of around 8.5% per annum over 17 years up to 2016; a much higher rate of growth than the population growth rate or the annual GDP growth rate [17]. It may be pertinent to observe that this escalation is likely to be much faster in reality, as the estimates made by Ratnayake & Jayasinghe (2001) appeared to have covered all dimensions of costs, including the cost of fatalities, property damage, medical costs, and police costs, as claimed by the authors, which were not included in the present study [17]. Even compared to the estimate made by Perera in 2016, which was a mere Rs 100 billion over 30 years from 1977 to 2007, the cost estimate from the present study of over Rs 140 billion for the four years from 2016 to 2019 indicates a pattern of a significant escalation of costs [18]. This rate of escalation is alarming, as it is indicative of the possibility of achieving a higher growth rate of the economy if not for the growth destructive effect of road traffic accidents.

It is important to perceive, however, that the resulting estimates of accident costs yielded through research have to be perceived with the proper understanding that those based on parametric values, and thus, the change in inflation, increase in the per-capita income and the exchange rate fluctuations play a significant role in the monetary estimates of the value of human life years lost owing to accidents. Therefore, the triangularisation of such cost estimates through different approaches becomes useful to expand the coverage as well as to enhance the confidence in the accuracy of such accident cost estimates. In this regard, a more refined perception of the "cost elements" that had been considered in the study conducted by Ratnayake & Jayasinghe (2001) could become useful to fathom what elements could be included in future research. Similarly, the estimates made in the present research based on YLL alone could be expanded to include "other dimensions" of cost implications, so that

an estimation of the overall costs of road traffic accidents could be attempted through future research.

Nevertheless, the scale of YLL-related cost estimates made in the present study provides insight into the cost of road traffic accidents for the Sri Lankan economy when all such implications are taken into account, as the total cost implications could be many-fold than the estimates made in this study. Therefore, policymakers can use the findings of this study to understand the magnitude of the socioeconomic burden imposed by road traffic fatalities in Sri Lanka.

6. CONCLUSIONS

In the context that many global studies have identified road traffic accidents as a growing social and economic burden, particularly on economically vulnerable developing countries, the present research endeavoured to estimate the economic cost of road traffic accidents in Sri Lanka, from 2016 to 2019, focusing on one particular dimension of the cost incurred; namely, the productive human life years lost owing to premature deaths caused by traffic accidents.

The results enabled us to infer that (i) road traffic accidents have been a growing concern in Sri Lanka and that (ii) the economic cost of lost human life years owing to premature deaths caused by road accidents, has been significant, representing nearly a quarter of a percentage of the GDP of a given year during the study period. The overall cost of accidents is bound to be much greater, given that the analysis in this study did not account for many other dimensions of cost such as property loss, health-related expenses, administrative costs and cost to the Department of Police, etc. Therefore, those made in this study could be considered as lower-bound estimates of the cost of road traffic accidents in Sri Lanka.

The outcomes of the research also revealed that the years of human life lost owing to traffic accidents grew during the study period, even though the number of road accidents reported appears to have trended down. This amounts to be yet another concern, as it could reflect a growing severity of accidents with a larger scale of impact on human lives. Therefore, it is important to identify, through future research, the factors which may have led to the increase in road traffic fatalities, and address those through appropriate preventive strategies. Such studies may focus on the different categories of causal factors of accidents, such as road conditions, climatic conditions, vehicle conditions, driver-related factors, and road user behaviour-related factors, to mitigate the augmenting scale of severity of road traffic accidents in Sri Lanka.

REFERENCES

[1] World Health Organization, "Global Status Report on Road Safety," WHO, Geneva, 2018.

[2] P. Amarasinghe and S. Dharmaratne, "Epidemiology of road traffic crashes reported in the Kurunegala Police Division in Sri Lanka," Sri Lanka Journal of Medicine, pp. 10-19, 2019.

[3] World Health Organization, "World report on road traffic injury prevention: Summary," World Health Organization, Geneva, 2004.

[4] World Health Organization, "Global Status Report on Road Safety: Time for action.," Department of Violence & Injury Prevention & Disability (VIP), Geneva, 2009.

[5] Pan American Health Organization, "Cost of Road Traffic Fatalities," 2004. [Online]. Available: http://www.paho.org. [Accessed 27 12 2019].

[6] T. Bhavan, "The relationship between per capita GDP and road accidents in Sri Lanka: An ARDL bound test approach.," Asian Journal of Empirical Research, pp. 8(7), 238-246., 2018.

[7] A.S. Kumarage and M.D.R.P. Jayaratne, "Comparison of accident rate between vehicle types in Sri Lanka," 2005. [Online]. Available: https://www.researchgate.net/publication/311375021.

[8] A. S. Kumarage and M.D.R.P. Jayaratne, "Analysis of trend in fatal accidents of vulnerable road users in Sri Lanka," 2006. [Online]. Available: https://www.researchgate.net/publication/311374787.

[9] P. Jeepara and S. Pirasath, "Road traffic accidents in Eastern Sri Lanka: An analysis of admissions and outcome," Sri Lanka Journal of Surgery, 2011.

[10] A. Atubi and K. Gbadamosi, “Global positioning and socio-economic impact of road traffic accidents in Nigeria,” American International Journal of Contemporary Research, pp. 136-146., 2015.

[11] Asian Development Bank, “The cost of road traffic accidents in Thailand,” Manila: ADB, 2009.

[12] A. Atubi, "Socio-economic effects of road traffic accidents in Nigeria - A Nexus," International Journal of Agriculture, Environment and Bioresearch, pp. 38-59, 2017.

[13] D. Mohan, "Social cost of road traffic crashes in India," Proceedings of the First Safe Community Conference on Cost of Injury, Denmark, 2002.

[14] R. Elvik, "Which are the relevant costs and benefits of road safety measures designed for pedestrians and cyclists?," Accident Analysis and Prevention, pp. 37-45, 2000.

[15] World Health Organization, "Preventing Road Traffic Injury: A public health perspective for Europe," WHO Regional Office for Europe, Copenhagen, 2004.

[16] A.S. Kumarage, U.E. Storm, T.L. Gunaruwan and D. Mudannayake, "Assessment of Public Investment in Transport Sector," (Report submitted to Department of National Planning, Ministry of Finance & Planning), University of Moratuwa, Moratuwa, 1999.

[17] L. L. Ratnayake and C. Jayasinghe, " Traffic accidents cost analysis," 2001. [Online]. Available: https://www.researchgate.net/publication/304237288. [Accessed 21 February 2020].

[18] C. Perera, "Legal aspects of motor traffic trauma in Sri Lanka," Egyptian Journal of Forensic Sciences, pp. 342-346, 2016.

[19] C. Murray and A. Lopez, "Progress and directions in refining the Global Burden of Disease Approach: A response to Williams," Health Econ, pp. 69-82, 2000.

[20] C. Murray, M. Ezzati, A. Flaxman, S. Lim, R. Lozano and C. Michaud, "GBD 2010: Design, Definitions, and Metrics," Lancet, pp. 380: 2063-2066., 2012.

[21] World Health Organization, "WHO Methods and Data Sources for Country-level Causes of Death 2000-2015 (Global Health Estimates Technical Paper WHO/HIS/HSI/GHE/2016.3)," WHO, Geneva, 2016.

[22] A.D. Lopez, C.D. Mathers, M. Ezzati, D.T. Jamison, and C.J.L. Murray (ed), "Global Burden of Disease and Risk Factors." Disease Control Priorities Project, The World Bank, Washington DC, and Oxford University Press, New York, 2006.

[23] World Health Organization, "WHO Methods and Data Sources for Global Burden of Disease Estimates 2000-2015," Department of Information, Evidence and Research, Geneva: WHO, 2017.

[24] C. Murray and A. Lopez, "Global Health Statistics: A Compendium of incidence, prevalence and mortality estimates for over 200 conditions," Cambridge: Harvard University Press, 1996.

[25] D.T. Jamison, J.G. Breman, A.R. Measham, G. Alleyne, M. Claeson, D.B. Evans, P. Jha, A. Mills and P. Musgrove (ed), "Disease Control Priorities in Developing Countries," 2nd Edition, The World Bank, Washington DC, and Oxford University Press, New York, 2006.

[26] E. Hauer, "Can one estimate the value of life or is it better to be dead than stuck in traffic?", Transport Research Series, pp. 109-118, 1994.

[27] World Health Organization, "WHO Methods and Data Sources for Global Burden of Disease Estimates 2000–2011," Department of Health Statistics and Information Systems, Geneva, 2013.

[28] CBSL, "Annual Reports", CBSL Press, Colombo, 2016, 2017, 2018, 2019.