Valuing the social costs of crashes: is community's willingness to pay to avoid death or injury being reflected?

Julie Perovic and Dimitris Tsolakis
ARRB Group, Melbourne, Vic, Australia

Abstract
The valuing of crashes in Australia is in need of review and update. Australia currently uses a human capital (HC) approach to the valuation of crash costs, while many other developed countries have adopted a willingness to pay (WTP) approach. This paper considers the current methodologies pertaining to estimation of safety effects and suggests that the value community places on prevention of loss of life and of serious injury would be better reflected by the implementation of the WTP approach. In addition, the practicalities of moving to a WTP estimation of crash costs are also discussed with respect to impacts on project evaluation.

1.   Introduction

Two major issues are considered in this paper regarding the appropriate valuing of road safety effects in Australia[1]. These refer to, first, the suitability of the methodology used to estimate the social cost of crashes, and, second, the extent to which safety related effects are properly considered within a whole of transport projects evaluation context.

The present methods of valuing social costs of crashes in Australia require a review and update. Australia's current use of the Human Capital (HC) costing framework has meant that it has fallen behind other developed countries with respect to adequately valuing life and serious injury. Furthermore, the methods being predominantly used to value the social cost of crashes are not necessarily able to support an efficient allocation of scarce resources to road safety and infrastructure projects.

To shed some light on the validity of the two key issues considered in the paper, a review of current methodologies pertaining to the valuation of safety effects has been undertaken to establish whether costing methodologies currently used adequately reflect the value the community places on prevention of loss of life or of serious injury. The share of safety benefits within the wider project evaluation framework (including reference to the Safe Systems approach) is assessed, and the possible implications to this share resulting from a possible move to a willingness to pay (WTP) costing approach are considered.

It appears that the costing framework and basic assumptions about the valuation of Road User Effects (RUE) components[2], which were derived a number of years ago, are now overdue for review and therefore may not reflect international best practice. A growing number of anomalies in evaluation algorithms have also been identified.

---

[1] This paper is based on a recent report ARRB has completed for the Austroads Safety Taskforce titled: *Component costs in transport projects to ensure the appropriate valuing of safety effects* (Tsolakis et al. 2008). It involved an extensive literature review and analysis of existing data as well as a main workshop with key safety and project evaluation experts to discuss the findings of this work, and to plan the next steps in valuing safety benefits in Australia.

[2] RUE components consist of (1) travel time costs, (2) crash costs, (3) vehicle operating costs (these three also commonly known as RUC – road user costs), and (4) environmental and other externalities, the use of which in project evaluation is explained further in the Section 2.

2.   **Project Evaluation in Australia**

This section introduces project evaluation in Australia, which provides a perspective on the relevance of valuing the social cost of crashes adequately.

Transport project investment is under increasing attention as a means to promote social and economic development. Stakeholders, particularly treasuries, need to be convinced of projects' value for money and contribution to the wealth of the nation or state. Transport project evaluation in Australia generally involves the inclusion of the following RUE components:

- **Vehicle operating costs (VOC)** constitute a key component of overall RUE in project evaluation. VOC items considered in project appraisal include:
  o   fuel consumption
  o   oil use
  o   tyre use
  o   repairs and maintenance
  o   vehicle depreciation.

    There has been significant variation in models used in Australia to determine VOC, which range from the NAASRA Improved Model for Project Assessment and Costing (NIMPAC) type models, to the more recent HDM (Highway Development and Management) family of models (e.g. HDM-4).

- **Travel time costs/savings** tend to account for the largest portion of the benefits of road projects. UK research indicates that travel time savings can provide up to 80% of the total monetised benefits of road projects (Mackie et al. 2001a and BTE 1999). Since the mid-1990s, Austroads has attempted to harmonise the methodologies and unit values used in travel time valuation in road project appraisal.

- **Social costs of crashes** to society are normally considered in project evaluation as a mixture of economic and social cost of crashes of different crash intensity (e.g. resulting in death, injury and property damage). There have been significant variations in approaches used to model crash costs in project evaluation and this is the major issue addressed in the remainder of this paper.

- **Externality costs** which account for the social costs of transport, have become increasingly important in calculating costs and benefits in project evaluation in recent years. Externality costs can vary in proportion from having a relatively small share of total costs (e.g. rural roads travel, which mostly only contributes to greenhouse gas (GHG) emissions and pavement damage), to a larger share for urban travel, when air and noise emissions, nature and landscape damage, urban separation and water pollution also become relevant.

3.   **An Introduction to the Valuation of Social Costs of Crashes**

The social costs of crashes normally refer to both the economic value of personal and material damages and the pain and suffering caused by vehicle crashes. VTPI (2005) defines internal crash costs, which are damages and risks to the individual travelling by a particular vehicle or mode, and external crash costs, which are uncompensated damages and risks imposed by an individual on other people – together producing the social cost of crashes. There are also insurance compensation costs, which are external to the individual but internal to the premium payers as a group. Within each category of costs, there are also market and non-market cost sub-categories, which reflect costs that can be directly measured in dollar terms and those which must be estimated, respectively.

Table 1 further discusses these costs within each category (VTPI 2005).

Table 1: Crash cost category

Cost category	Market costs	Non-market costs
Internal	Safety equipment expenditures Uncompensated property damage, lost income and medical cost to users Insurance deductibles	Uncompensated pain and lost quality of life to crash victims
External	Uncompensated property damage, lost income and medical costs to non-users Emergency response and crash prevention expenditures	Uncompensated pain and lost quality of life borne by non-users (e.g. non driving public) Uncompensated grief to victims' loved ones Reduced motorised mobility
Insurance	Property damage, lost income and medical treatment compensated by insurers	Pain, grief and lost quality of life compensated by insurers

Source: VTPI (2005)

Elvik (1994) estimated that 37-44% of Norwegian crash costs are external, while Transport Concepts (1994) provides a range for external costs from 3-47%, suggesting the upper bound to be more reflective of actual costs. The wide ranges proposed in these studies indicate that the total cost of crashes can vary heavily depending on the method of valuing external costs. The internal cost of crashes – or the value of a statistical life – generally accounts for over half of total accident costs, and this value, in turn, is heavily dependent on the methodology implemented (VTPI 2005).

Evaluation of the social cost of crashes is not an exact science. Several methodologies have been formulated and applied, yet there is no one unique technique which is unanimously accepted. There are two established methods of evaluating social costs of crashes – the willingness to pay (ex ante) approach and the human capital (ex post) approach:

- The willingness to pay (WTP) approach values society's willingness to pay for avoiding death, injury, and damage outcomes from road crashes.

- The human capital (HC) approach is described as 'resting on accounting principles, the benefit of avoiding a premature death is given by the present value of the income flow the economy could lose in that case' (Rizzi and Ortuzar 2005).

The following sections explore the methods used in Australia and other countries to value the social cost of crashes. They also consider the impacts on transport project evaluation - particularly if Australian agencies decide to adopt a valuation approach consistent with the community's willingness to pay for reducing the risk of getting killed or injured when travelling.

3.1   Australian and International Valuation of the Social Cost of Crashes

Australia is one of the few developed countries still using the human capital approach to estimating crash costs. The human capital approach to valuing crash costs is seen as an objective measure as it considers the value of lives saved and disabilities reduced – factors which can be priced by labour markets (Giles 2003).

In recent times, a number of developed countries have adopted a WTP (or similar) approach to determine the social costs of crashes. The UK and New Zealand adopted the WTP methodology in 1988 and 1991 respectively, while Sweden shifted from the cost-based approach to a WTP approach for the pricing of a statistical life for road risks in 1989 (Giles 2003). In North America, Transport Canada adopted a WTP-based 'fatality avoided' method in 1991 and the US moved from a human capital based methodology to a WTP approach in 1993. In more recent years, most of the WTP valuations across these countries have employed the 'contingent valuation' method to determine values for the social costs of crashes.

The estimation of the social cost of road crashes in New Zealand is based on a WTP approach. A value of statistical life (VOSL) of $2 million was estimated in 1991, following a WTP survey carried out during 1989-90. Since then, the VOSL estimate has been indexed to average hourly earnings to update the VOSL value to current prices. Estimates for the social cost of road crashes are produced annually for rural and urban areas for crashes and injuries, in terms of crash severities of fatal, serious, minor and property damage only crashes. The updated VOSL as per June 2006 was NZ$3.05m, resulting in an average social cost per fatality of NZ$3.065m, NZ$535,000 per serious injury and $60,000 per minor injury. The June 2007 update on the social cost of crashes (New Zealand Ministry of Transport 2007) estimated the statistical value of life to be NZ$3.21 million.

3.2   The Human Capital Approach

The human capital approach attempts to estimate the impact of life loss or injury on current and future levels of output. The major component in this valuation approach is the victim's future output – typically measured by income lost. Income is typically calculated before tax, with imputations being made for those individuals whose activities are not readily valued by markets – such as household duties. In some cases when implementing the human capital approach, an attempt is made to also value the pain, suffering and grief ('human cost') that may also result from road crashes. However, this 'human cost' component is usually arbitrarily determined. In the transport safety context, vehicle damage, medical costs and other costs can also be included when valuing life using the human capital approach (BTCE 1996).

3.2.1   Advantages of the human capital approach

The most commonly identified advantage of the human capital approach is that it is relatively simple to calculate and use, as BTCE (1996) concludes. Robinson (1986) asserts that the human capital approach 'not only provides a reliable and internally consistent set of numbers, but it has a strong theoretical foundation, and as such can provide useful information to decision makers in the public sector'. The human capital approach provides the necessary values to undertake project evaluation in the absence of adequate estimates based on the WTP approach.

3.2.2   Disadvantages of the human capital approach

Perhaps as a result of the simplicity of the human capital approach, there are problems resulting from the use of the market wage as the proxy for an individual's marginal product – with issues such as labour market discrimination potentially providing incorrect values, the inherent undervaluation of life for groups such as children and the elderly who do not contribute relatively as much to economic output. There have been attempts to rectify these inadequacies (such as attempting to value the contribution of home-makers and the value of externalities like pain and suffering), but much of the time this involves the difficulty in valuing intangible cost elements.

BTCE (1996) found several previous studies which identified a common criticism of the human capital approach with respect to benefit-cost analysis (BCA)– most people value safety due to their aversion to the prospect (minimise risk) of serious injury or death for themselves and others, rather than as a means of preserving current and future output and earnings.

Table 2 summarises the results of a number of studies that have estimated social costs of crashes in Australia using the human capital approach.

Table 2: Social cost of crashes in Australia estimated using the human capital method

Author	Date of publication	Base year	Region covered	Total crash cost estimate*	Average value of life estimate
Troy and Butlin	1971	1963	ACT Only	$4.1m	$48,600
Atkins	1981	1978	Australia	$1,591.1m	$220,450
Steadman and Bryan	1988	1985	Australia	$5,233.7m	$399,000
BTCE	1992	1988	Australia	$6,130.8m	$632,000
BTE	2000	1996	Australia	$14,980.0m	$1.7m

* Total crash costs include values of life – i.e. lost production, and forgone income.

3.3   Willingness to Pay Approach

Attempting to value the impact of any transport policy on society is seen to be measured by peoples' strength of preference for safety initiatives under the WTP approach (BTCE 1996). Furthermore, the value derived by extracting the maximum amount an individual is willing to pay for an extra unit of safety indicates not only the individual's preference of safety relative to other commodities, but also reflects what the individual is able to pay.

There are four techniques which exist in cost derivation via the WTP method (Giles 2003):

- **Contingent valuation** – survey respondents are asked their willingness to pay for a particular good. Conduct of contingent valuation surveys has the potential for introducing inconsistencies in the estimation of values, if surveys and survey questionnaires are not carefully and competently designed and executed.

- **Hedonic pricing** – assumed that a good or service is composed of a group of characteristics that together can be combined in ways that increase or decrease the benefit. Differences in price between different groupings therefore estimate the willingness to pay for particular characteristics.

- **Revealed pricing** – attempts to identify risk appetite through estimating the value of life based on differences in wages for occupations of different risks.

- **Standard gamble** – respondents are given a scenario which includes their hypothetical involvement and provides them options of treatment based on a variety of risks.

3.3.1   Advantages of the WTP approach

As opposed to assigning a specific value to an injury or life lost, the WTP approach values the small changes in probability of injury or death that an individual could gain from a road safety intervention. Therefore, 'an individual's willingness to pay divided by the reduction in the risk of death is simply the person's marginal rate of substitution of wealth for a reduction in the risk of death' (BTCE 1996).

The WTP approach is recognised as the theoretically sound method for valuing life and aversion to death and injury. According to Miller and Guria (1991), if an individual will respond rationally to the risks that they and their families perceive, their response should reveal their willingness to reduce injury and/or death. The resulting value should, therefore, reflect the following:

- the family's monetary costs of illness, injury and death
- the impacts on quality of life from injury (pain and suffering of self and loved ones)

- the sense of security derived from being safe and healthy
- people's aversion to gambling involuntarily with their lives and livelihoods.

In addition, from the project evaluation perspective, moving away from the HC approach and adopting a WTP approach could alter the allocation of funding among road safety projects – perhaps increasing the likelihood that previously rejected projects obtain funding.

Many economists have increased their support for the WTP approach. The perspective held is that the approach is superior in its ability to comprehensively measure the value placed on life and safety as well as the desired avoidance of subjective elements including pain, suffering and grief (BTCE 1996).

3.3.2   Disadvantages of the WTP approach

The WTP approach has also received criticism on various grounds such as the quality of people's perception of risk, the fact that people often ignore external social costs when making decisions and that in some cases people actually gain utility from taking risks. In order to make the WTP approach to costing road crashes successful, people will need to be fully informed of the risks of death and injury associated with specific transport modes. Furthermore, the approach has been criticised on the basis of not adequately reflecting equity. When undertaking a benefit-cost analysis, there is an assumption that the marginal utility of money is equal for rich and poor people, and if this is not the case, then results will not adequately reflect all of society's objectives, even if the outcomes appear to be economically efficient.

Such criticisms of the WTP approach do not necessarily undermine the theoretical merit of this method, but they do highlight the difficulties in estimating values. These are the difficulties which need to be addressed when developing the methodology to implement the WTP approach to valuing road crashes. Table 3 (reproduced here from BTCE 1996) indicates the range of estimates of the statistical value of life in the US obtained using a WTP approach. This variation can reflect a number of important factors including timing and other specific empirical conditions for each study, but can also be an indication of the preferences of community members to various options involving a reduction in the risk of loss of life.

Table 3: Estimate of the value of statistical life in the US

Agency	Year adopted	Value in 1991 A$ million

Department of Transport:
   Land
   Air
   Water
	1986	1.9
		 2.2
		 1.3

Department of Agriculture	1985	1.4
Office of Management and Budget	1985	1.3-2.5
Environmental Protection	1983	2.1-10.2
Consumer Product Safety Commission	1981	2.5
Occupational Safety and Health Administration	1983	2.5-4.5
Nuclear Regulatory Commission	1979	8.0

Source: BTCE (1996)

3.3.3   Estimates obtained by employing the WTP approach

Table 4 presents a selection of 1990s studies which used the different techniques applicable to the *ex ante* WTP method of road crash costing to estimate these costs in the US, UK and Australia (Giles 2003). Giles (*ibid*) presents the results of these selected studies to discuss the considerable variation which exists with the estimates produced. However, a closer and more consistent investigation of the empirical applications on which these studies are based may be required to explain the apparent variation of estimates across these studies. The context of the samples used regarding attitudes and preferences to risk and the associated demographic factors would be important to consider when attempting to understand the difference in estimates.

Table 4: Social cost of crashes estimates using ex ante (WTP) techniques

Author	Date published	Base Year	Country	Type of risk	Method	Estimate
Bloomquist	1996	1991	USA	Fatality Moderate - serious injury	Revealed preference	US$2m US$70,000
DOT (UK)	1996	1995	UK	Fatality Serious Slight	Contingent valuation	£812,010 £92,570 £7,170
DETR (UK)	2000	1999	UK	Fatality Serious Slight	Contingent valuation	£1.089m £122,380 £9,440
DTLR(UK)	2001	2000	UK	Fatality Serious Slight	Contingent valuation	£1.145m £128,650 £9,920
Jones-Lee	1995	1990	UK	Serious	Standard gamble	£70,000
Kneiser and Leeth*	1991	1995	Australia	Fatality	Revealed preference	US$2.126m

* These values were updated by Miller in 2000 (Giles 2003)
Source: Giles (2003)

3.4   Primary difference between the HC and WTP approaches

Overall, the primary difference in the two approaches comes from the starting point of each method. The HC approach is concerned with the associated costs and lost future earnings of resulting from death; while the WTP approach considers the overall 'value of life' individuals hold. Earnings alone are not enough to capture the value and desire society places on life – which the HC approach cannot account for. Therefore, the estimates practitioners select must take note of what is, and is not, reflected by each method used. If the intent of practitioners is merely to account for the lost potential future earnings and the cost of road fatalities, then the HC will suffice. Alternatively, if a welfare economics perspective is taken by practitioners with the aim of encapsulating society's overall aversion to death and injury, then the WTP approach would be useful and more appropriate than the HC method (BTCE 1996).

Further to this, when carrying out cost-benefit analysis, the WTP approach is more successful in its ability to reflect society's welfare. As a result, using WTP estimates is consistent with a government's objective to maximise social welfare – as opposed to just minimising costs, for which HC estimates could suffice (BTCE 1996).

WTP is the theoretically correct concept to use, but it can only be demonstrated fully after WTP robust estimates are available for Australia. The WTP method is not widely adopted because of data availability and quality issues - including empirical difficulties with sampling questionnaire design and application, and cost of becoming WTP 'literate.' Key experts and jurisdictions (e.g. BTRE, RTA and other in Australia) have considering the implications and already moved in the WTP direction.

Without WTP estimates is not possible to benchmark Australia's practice to that of other economies or societies which lead in the area of road safety (e.g. Sweden, UK). We tend to want to follow their innovative approaches in this area, but cannot easily assess our success as followers if we do not have comparable information (data) and methodologies.

Lastly, in addition to the differences and developments described above, international estimates of value of a statistical life (VOSL) vary greatly in dollar terms depending on the method of estimation used. Table 5 below shows the estimates of VOSL for developed and developing countries as summarised in a recent iRAP report (Dahdah and McMahon 2007). These values are expressed in 'International $' (presumably US$). GDP per capita values are also reported for each of the countries included in the table, as is the respective valuation method used in each country.

Table 5: Estimates of economic costs of crashes

Country	VOSL 2004 International $	GDP/Capita 2004 International $	Method
Australia	1,304,135	28,935	HC
Austria	3,094,074	35,871	WTP
Bangladesh	71,066	1,710	HC
Canada	1,427,413	29,851	HC
France	1,252,083	29,472	HC
Germany	1,257,451	28,953	HC
Iceland	3,303,555	44,679	HC + PGS*
India	147,403	2,651	WTP
Indonesia	92,433	3,125	HC
Latvia	1,042,743	18,140	HC
Lithuania	746,531	12,027	HC
Malaysia	722,022	9,513	WTP
Myanmar	51,254	1,545	HC
Netherlands	1,944,026	31,009	HC + PGS
New Zealand	2,033,333	25,024	WTP
Poland	573,806	14,984	HC
Singapore	924,240	25,034	HC
Sweden	2,015,680	32,394	WTP
Thailand	222,056	6,958	HC
UK	2,292,157	32,555	WTP
USA	3,000,000	36,311	WTP
Vietnam	53,063	2,475	HC

*PGS indicates some provision for pain, grief and suffering, intended to represent the 'human cost'

4   Social Cost of Crashes within the Project Evaluation Framework

4.1   Practice in Evaluation of Road Transport Projects

Regardless of the method used to calculate them, crash costs are incorporated into road transport infrastructure project evaluations to value crash cost savings arising from different road project options. They are normally expressed by accident severity (e.g. fatal, serious and minor – see Vickerman 2000 and Rothengatter 2000), with appropriate accident rates and risks per road type and traffic volume (as well as injury rates per crash type, speed type) incorporated into the project evaluation approach (also requiring revision and updating from time to time)[3].

The *Austroads Guide to Project Evaluation* (Austroads 2005) also identifies the key variables affecting road crash costs as: traffic volume, road type, rainfall, road curvature and speed limits. Together with travel time savings, crash cost savings are one of the key RUE components of project evaluation (Bristow and Nellthorp 2000)[4].

---

[3]   Or as Hauer (1982) in Koornstra (1992) states that Safety = Risk x Exposure.

[4]   See Table 2.1 in the Austroads Guide to Project Evaluation for a detailed set of variables influencing each RUE component as well as other components of project evaluation, e.g. construction and maintenance costs (Austroads 2005).

4.2   Relative Share of Social Cost of Crashes in Cost Benefit Analysis

The relative share of safety benefits in road project evaluation is susceptible to substantial variation. When compared to the base case proportions, some options might generate increased travel time costs (and reductions in VOC) together with reductions in crash costs (see *Austroads Guide to Project Evaluation* 2006, Part 8, Black Spot Treatment example), while others might show reductions in travel time, and crash costs, together with increased VOC.

These possibilities imply, for example, that benefits in crash cost savings may be made insignificant to some extent by increases in travel time costs or VOC, depending on the project. Expressed another way, the relative share of crash costs as a proportion of total costs of a project option seem to be in the range of 10-20% (Austroads 2006), although this will vary significantly depending on the type of project and options put forward. Therefore, given the magnitude of travel time costs on a project, it is relatively easy for even small increases in travel time costs (or VOC for that matter) to render crash cost savings insignificant (as they represent a smaller proportion of project costs).

4.3   Relationship between Road User Effects

The individual and combined values of RUE components are relevant in making travel decisions. They form key ingredients in the mix of making trip decisions by users, such as - fuel cost, travel time and crash risk considerations. As a result, it is important to recognise a more integrated approach of estimating these costs within a wider evaluation framework.

4.3.1   Safety and mobility

There is a trade-off between travel time savings and savings in crash costs that needs to be taken into account (Austroads 2004), i.e. traffic improvements that improve mobility and reduce travel time might impact negatively on safety, through increased travel speeds. Of course, this also raises the issue of safety and mobility referred to in more detail below, in respect of which Haight (1994, p. 24) states that:

> *Speed limits are directly linked to safety (through travelling-speed distributions and hence to injury-severity levels) and to mobility (through travel time changes).*

According to Haight (*ibid*), the safety-mobility relationship works both ways. Mobility brings with it increased numbers, usage of vehicles (e.g. travel measured in VKT) and speed, therefore impacting on exposure, risk and therefore safety (increased crash costs). Similarly, safety measures also affect mobility, e.g. a stop sign reduces the risk of crashes, but may also result in increased travel time (delay) and vehicle operating costs. Another example is that of the imposition in the US of a 55mph speed restriction in the early 1970s, which resulted in estimated travel time costs that were 57% greater than the estimated safety savings that arose from the initiative[5]. The relationship between speed and mobility is therefore negative in terms of speed (limits). However, there are examples that prove counter to this. For example, the M25 variable speed limit scheme introduced lower speed limits at peak times. This had the effect of regulating traffic flow resulting in quicker journey times and slightly improved safety (Rees et al. 2004). There is also limited evidence to show that (at least in congested conditions) changes in speed limits on arterial roads had a minimal impact on journey times. Similarly, Campbell (1992) also refers to instances where the relationship may be positive (e.g. in the case of certain traffic interventions)[6].

The Land Transport New Zealand (LTNZ) Economic Evaluation Manual (EEM) (LTNZ 2005) draws attention to the impacts of measures taken to reduce traffic congestion on safety:

---

[5] Although it should not be forgotten that the speed restrictions in the US, and other countries for that matter, were reactions to the fuel crisis of the early 1970s and not ostensibly safety measures in all cases.

[6] See Campbell (1992) for a useful matrix used to analyse the safety-mobility implications of various kinds of transport interventions. He also examines several useful examples involving the safety-mobility trade-off in that case, e.g. the case of restrictions on young drivers for safety reasons which in turn affects their mobility.

Programmes that reduce traffic congestion without reducing total kilometres travelled, by shifting travel times and routes, have mixed safety benefits: although accidents tend to decline, collisions that do take place tend to be more severe (and therefore have higher resource cost) because they occur at higher speeds. (LTNZ 2005 Part 2, pp. 3-21).

The relative share of safety benefits in project evaluation may not only be affected by the valuation methodology applied (HC vs WTP) but may also be affected by the valuation methodology applied to other RUE components, e.g. value of travel time. Travel time savings may provide up to 80% of the total monetised benefits of road projects (Mackie et al. 2001 and BTE 1999), thereby offering significant potential for altering the relative share of benefits amongst the RUE components, if methodological changes reduce the size of these benefits. In this regard, the exclusion of small travel time savings has been raised in the literature (Welch and Williams 1997). If small travel time savings are excluded, for example, the possibility exists that their relative share of benefits reduces and others increase (e.g. crash cost savings). However, it must be noted that there is also a counter-argument that small travel time savings should continue to be valued (Haight 1994), in some cases perhaps to a greater extent than large travel time savings (BTE 1999).

5   RUE Evaluation Techniques and Project Evaluation

This paper has considered the two different methods of evaluating the social cost of crashes. The other RUE components also have varying methods of derivation – different to what is presently being applied. With respect to project evaluation, the method of valuing each RUE is potentially important to the overall final result – and hence to the practitioners final decision.

5.1   Social cost of crashes

Looking at some of the reported values for a statistical life (e.g. those presented in **Error! Reference source not found.**2, **Error! Reference source not found.**4 and Table 5), it is important to understand the implications and significance resulting from the differences in using the WTP and human capital approaches in valuing crash costs. Firstly, it is imperative to recognise that there is an appreciable difference between the estimates produced by each method – irrespective of base years and exchange rates, the differences are significant. Furthermore, the estimates are not empirically stable, with the values varying notably across countries and years depending on the approach used.

Giles (2003) and BTE (2000) suggest that the application of the WTP approach in Australia would have a marked impact on crash cost estimation. Using a WTP method, Giles (2003) estimated that the cost of road crashes in Australia in 1996 could be as much as $344.82 billion, with the value of a statistical life ranging from $12.4m-$21.5m in 1996 dollars. Comparing this to the BTE (2000) human capital approach estimates of total crash costs in 1996 being $15 billion, it is clear that the differences are notable. Giles (2003) also compared the 1996 Australian estimates of fatalities based on the human capital approach (A$1.58m per fatality) with fatality estimates from the UK (A$1.98m per fatality) and US (A$3.26m per fatality) and found substantial variation. Such differences are bound to have implications on how safety treatments only projects are considered within the broader allocation of constrained funds for road infrastructure and operations projects.

The final project evaluation numbers could differ substantially depending on which method is used to derive the social cost of crashes. Therefore, the obvious implication for road project evaluation due to moving from a human capital to a WTP approach is that the latter (based on available sources) suggests an increased value for crash costs and therefore increased valuation (and relative share) of safety benefits. Some sources suggest this might result in overall crash costs doubling or even tripling (see earlier discussion in Section 3). In addition, it is important to determine if the ultimate ranking of safety/transport projects will vary depending on the approach to be used to value crashes or lives lost (Giles 2003).

However, even if the WTP approach results in larger estimates of crash costs that are robust (see earlier critique on the WTP approach in Section 3.3) and are acceptable to jurisdictions across Australia, changes in the relative share of safety benefits in project evaluation will still depend upon:

- methodology used to estimate travel time costs
- assumptions and relevance of VOC models
- how environmental externalities are valued
- accident rates and risks inherent in the road types making up the project, as well as injury rates per accident type, road type and speed – their relevance to the situation and how up to date they are.

As a result, even if crash cost estimates double or even triple, the effect on the relative share of safety benefits in road project evaluation will not be of the same order, due to the relative sizes of safety and other benefits (e.g. travel time). The methodologies used to calculate other RUE components will also be important in the valuation of safety benefits, as will other components of the way in which safety benefits are calculated in project evaluation (e.g. the relevance and updating of crash rates and potential effectiveness of typical accident reduction factors of various treatments). Simply switching from a human capital to a WTP approach does not automatically guarantee that safety projects will attain significantly higher BCRs than previously.

5.2   Other road user effects

It has been suggested in Austroads (2004) that there should be consistency between the approaches used to value travel time savings and crash cost savings in project evaluation. Austroads has argued that there is inconsistency between values of travel time savings based on consumer preferences (a WTP approach) and crash costs savings based on a human capital approach. However, it has also been stated that consistency in methodology only becomes important when projects involve trade-offs between travel time savings and crash costs, an issue that has been raised in the evaluation of changes to speed limits (Austroads 2004).

6   Concluding comments

Theoretically, the WTP approach is the most appropriate method for determining crash costs. Although significant improvements have been made in recent times to the human capital method calculations in Australia, the WTP method of valuation is 'conceptually' correct and better reflects the value society places on safety. A WTP method is also consistent with the safe system approach to road safety, which has been recently embraced throughout Australia.

In the late 1980s and early 1990s, countries such as the US, Canada and New Zealand adopted the WTP approach. Since that time, Australia has 'fallen behind' by underestimating the value of lives lost to road crashes and associated safety benefits when applying the Human Capital (HC) approach.

An appropriate methodology framework is required for the development of WTP values in Australia, and this seems an obvious starting point for further work on this topic. The barriers to adopting a WTP approach in Australia include the development of an appropriate methodology, the cost involved, and a reluctance to change.

While considering a WTP approach for Australia, a unified and consistent approach should be pursued in evaluating all RUE components simultaneously. This would yield maximum safety benefits and other project benefits for the community, and ensure that society's scarce resources are used efficiently and in an environmentally and socially sustainable manner.

It is important that the approach used and the lessons learnt from recent New South Wales RTA work in this area, as well as the New Zealand experience established over a number of years, be carefully considered. Similarly, other non safety related successful WTP (Stated Preference) studies in Australia and overseas should be considered.

Whatever the costs and other barriers are, commitment and appropriate funding will need to be identified to progress this work. There is obvious interest from all jurisdictions in Australia for a coordinated approach to be developed and adopted.

Work that is currently being conducted by Austroads on updating the broader road user effects (RUE) costing methodologies can be also better coordinated to ensure consistency and effective use of resources.

In the short-run, attempts to improve the human capital approach should continue. It may be some time before acceptable values based on the WTP approach are developed in Australia. In the absence of such values, the human capital approach provides the necessary values to currently undertake project evaluation. However, there are various methodological issues with this approach (such as treatment of values for different groups in society, especially children and the elderly) which need to be examined and, if appropriate, improved.

References

1.   Atkins, A.S 1981, The economic an social costs of road accidents in Australia: with preliminary cost estimates for Australia 1978, report CR 21, Centre for Environmental Studies, University of Melbourne, Melbourne, Vic.
2.   Austroads 1997, Value of travel time savings, IR-119/97, Austroads, Sydney.
3.   Austroads 2004, Consistent cost estimation for evaluations: scoping study, internal report, IR-65, Austroads, Sydney.
4.   Austroads 2005, Guide to project evaluation, part 3: models and procedures, AGPE03/05, Austroads, Sydney.
5.   Austroads 2006, Guide to project evaluation, part 8: examples, AGPE08/06, Austroads, Sydney.
6.   Bristow, AL & Nellthorp, J 2000, 'Transport project appraisal in the European Union', Transport Policy, vol. 7, no.1, pp. 51-60.
7.   Bureau of Transport and Communications Economics 1996, Valuing transport safety in Australia, working paper 26, BTCE, Canberra, ACT.
8.   Bureau of Transport Economics 1999, Facts and furphies in benefit cost analysis: transport, report 100,BTE, Canberra, ACT.
9.   Bureau of Transport Economics 2000, Road crash costs in Australia, report 102, BTE, Canberra, ACT.
10. Campbell BJ 1992, 'Safety versus mobility', Journal of International Association of Traffic and Safety Sciences, IATSS Research, vol.16, no. 2, pp.149-56.
11. Dahdah, S & McMahon, K 2007, The true cost of road crashes – valuing life and the cost of a serious injury. iRAP, UK.
12. Elvik, R, 'The external costs of traffic injury: definition, estimation, and possibilities for internalization,' *Crash Analysis and Prevention*, Vol. 26, No. 6, 1994, pp. 719-732.
13. Giles, M 2003, 'The cost of road crashes: a comparison of methods and recent Australian estimates', Journal of Transport Economics and Policy, vol. 37, no. 1, pp.95-110.
14. Haight, FA 1994, 'Problems in estimating comparative costs of safety and mobility, Journal of Transport Economics and Policy, vol. 28, no. 1, pp 7-30.
15. Koornstra, M 1992, 'The evolution of road safety and mobility', Journal of International Association of Traffic and Safety Sciences, IATSS Research, vol. 16, no. 2, pp129-48.
16. LTNZ 2005, Economic evaluation manual, parts 1 & 2, Land Transport New Zealand, Wellington, New Zealand.
17. Mackie, PJ, Jara-Diaz, S & Fowkes, AS 2001, 'The value of travel time savings in evaluation', Transportation Research, vol. 37E, no.2-3, pp. 91-106.
18. Miller, TR & Guria, J 1991, 'The value of a statistical life in New Zealand', report for Land Transport Division, Ministry of Transport, Wellington, New Zealand.
19. New Zealand Ministry of Transport 2007, The social cost of road crashes and injuries June 2007, Ministry Transport, New Zealand, viewed July 2008 , <http://www.transport.govt.nz/socialcost/>.
20. Pratt, C 2002, Estimation and valuation of environmental and social externalities for the transport sector, 25th Australasian Transport Research Forum, Canberra, BTRE, Canberra.
21. Rees, T Harbord, B Dixon, C Abou & Rahme M 2004, Speed control and incident detection on the M25 controlled motorway, TRL report PPR033, TRL, United Kingdom.
22. Rizzi, L & Ortuzar, JDD 2005, 'Estimating the willingness-to-pay for road safety improvements', Transport Reviews, vol. 26, no, 4, pp. 471-485.
23. Robinson, J. C. (1986). Phiosophical origins of economic evaluation of life. *The Milbank Quarterly, 64*(1), 133-155.

24.   Rothengatter, W 2000, 'Evaluation of infrastructure investments in Germany', Transport Policy vol.7, no.1, pp 17-25.

25.   Steadman, LA & Bryan, RJ 1988, Cost of road accidents in Australia, occasional paper 91, Bureau of Transport Economics, Canberra, ACT.

26.   Thoresen, T & Roper, R 1996, Review and enhancement of vehicle operating cost models: assessment of non urban evaluation models, ARR 279, ARRB Transport Research Ltd, Vermont South, Vic.

27.   Transport Concepts 1994, *External* costs of *truck and train*, report prepared for the Brotherhood of Maintenance of Way Employees, Ottawa, Canada.

28.   Troy, P N, & Butlin, NG, 1971, The cost of collisions, Cheshire, Melbourne, Vic.

29.   Tsolakis, D, Turner, B, Perovic, J and Naudé, C 2008, Component costs in transport projects to ensure the appropriate valuing of safety effects, Report RCSS8383, ARRB Group Ltd, Vermont South, Vic.

30.   Vickerman, R 2000, 'Evaluation methodologies for transport projects in the United Kingdom', Transport Policy, vol. 7, no. 1, pp. 7-16.

31.   Victoria Transport Policy Institute 2005, Transportation cost and benefit analysis – safety and health costs, VTPI, Canada, viewed April 2008 <http://www.vtpi.org/tca/>.

32.   Welch, M & Williams, H 1997, 'The sensitivity of transport investment benefits to the evaluation of small transport savings' Journal of Transport Economics and Policy, vol. 31, no.3 pp. 231-54.