REVIEW OF THE USE OF THE DEPARTMENT FOR TRANSPORT VALUE FOR PREVENTING A FATALITY IN NON ROAD-TRANSPORT SYSTEMS

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Abstract

When safety practitioners contemplate the construction of safety arguments, there is often the requirement to establish a financial measure of various accident severity classes so that cost-benefit analysis can take place on proposed mitigation efforts. Very often the method of establishing costs utilises the UK Government Department for Transport (DfT) determined benefit value for the prevention of a fatality in a road traffic accident. This is used as a marker for the accident class relating to a single fatality and a fatality accident, with a series of other values used that are based on a logarithmic to the base 10 scale. Studies and reports discussing costs and values associated with accidents have been researched and appear to indicate that the almost blind use of the DfT valuation across diverse industry systems may not be fully appropriate [e.g. 3, 4]. This paper discusses the use of the DfT value of a prevented fatality as a value for cost-benefit analysis in various industries, compares cost components of accidents in those industries, and offers guidance in determining appropriate values for analysis of proposed mitigation efforts.

1 Introduction

In 2005 (the most up to date information available at the time of writing the paper), there were 2,913 recorded fatal road traffic accidents. There were 25,025 serious accidents and 170,793 slight accidents recorded. In addition, there were an estimated 3m damage-only accidents. The total value of prevention of all road accidents in 2005 has been estimated to be £17.85m [2].

This figure relates to the total value to the community of the benefits of prevention of road accidents. Some elements of the costs represent direct costs of the road traffic accident, however, human costs are also calculated which represent the ex ante benefit of avoiding the accident rather than the ex post values of the consequence of the accident [ibid.]. Whilst any accidental fatality might be seen as having an equal human ex ante benefit from whatever cause, the direct costs will vary dramatically depending on the industry where the accident may take place.
There are also arguments for differences based on subtle contrasts in the scope of an accident event, and on a concept of public aversion to, or dread of, an accidental fatality through particular causes.

The rest of this paper is organised as follows: section 2 will review the construction, scope and boundary of the DfT values for preventing certain events; section 3 reviews the applicability of the DfT values to rail transport. Section 4 reviews the applicability of the DfT values to the defence industry; section 5 discusses components of the DfT values that should be treated with care if they are to be used in other industries; section 6 discusses some additional components that perhaps should be included in the prevention value calculation. Section 7 provides a summary, recommendations and conclusion statements.

2 Construction, Scope and Boundary of the DfT values

In the case of a road traffic fatality event example, the elements of cost that are used by the DfT are as follows – the average value of prevention of a series of severities of accident are also given [2].

Cost Element	Fatal	Serious	Slight	Damage only
Lost Output	547,290	21,920	2,660	-
Medical costs	5,450	13,130	1,130	-
Human costs	1,080,290	149,030	12,660	-
Police costs	1,660	230	50	3
Insurance & Admin	260	160	100	50
Property Damage	9,830	4,460	2,650	1,660
TOTALS	**1,644,780**	**188,930**	**19,250**	**1,713**

Table 1: Average value of prevention per accident by severity and element of cost (£).

A review of this table of severities and cost elements for road traffic accidents gives rise to several important aspects of its information that have a dramatic affect on the adequacy of its use in other industries. These are as follows.

2.1 Ratio between total values of accident severity.

The sum of the total average values of each of the accident severities has been calculated to be as shown in the final row of Table 1 above. The ratio of these, taking the average value of the fatal class as 100, is as shown in Table 2 below [ibid.].

Accident Severity	Value of Prevention (£)	Ratio
Fatal	1,644,790	100
Serious	188,920	11.5
Slight	19,250	1.2
No Damage	1,710	0.1

Table 2: Ratios of average values of each accident severity

The ratios shown in Table 2 do indicate that each reducing accident severity class has a calculated prevention value reducing by almost an exact factor of 10 for each class. This aligns very well with accident risk matrices that are developed using logarithmic spacing between each severity and probability category. This is certainly one of the reasons why these exact values are utilised in industry sectors away from road transport.

2.2 Influence on the total of each value element.

The ratios of the influence of each value element for each severity class, taking the total as 1, are as shown in Table 3 below.

Cost Element	Fatal	Serious	Slight	Damage only
Lost Output	0.333	0.116	0.138	-
Medical costs	0.003	0.069	0.059	-
Human costs	0.657	0.789	0.658	-
Police costs	0.001	0.001	0.003	0.002
Insurance & Admin	0.000	0.001	0.005	0.029
Property Damage	0.006	0.024	0.138	0.969
TOTAL	1.00	1.00	1.00	1.00

Table 3: Ratios of the influence of each value element on the total value, for each accident severity class.

The ratios shown in Table 3 do show that several of the value elements have very little influence on the total value, and that this is fairly consistent across the accident severity classes. The main elements that have the most influence are 'lost output', 'human costs' and 'property damage'. If the Department for Transport derived value for preventing a fatality are to be used across other industry domains, the values and ratios shown in Tables 2 and 3 would need to be roughly consistent in the new domain for the application to be considered appropriate.

It should be noted that the property damage value is almost insignificant in fatal and serious injury classes, but obviously it is the predominant value in damage only incidents. Consistently highest in all accident severities where it occurs is the value attributed to human costs. The derivation of these value components is discussed below.

2.3 Derivation of the Lost Output values.

This is calculated as the present value of the expected loss of earnings plus any non-wage payments that would have been paid by the employer (inclusive of salary, National Insurance and pension contributions etc.) to the victim of the accident event over what would have been the expected life span. This is averaged across all recorded fatalities and is dependent on several factors, but mainly age and occupation. The younger the victim, the higher the value potential, and the higher the occupational wage or salary, the higher the value potential.

2.4 Derivation of the Human Cost values.

The value of the human cost element is determined using a 'willingness-to-pay' method. This represents pain, grief and suffering to the casualty, relatives and friends, and for fatal casualties, the intrinsic loss of enjoyment of life over and above the consumption of goods and services [2]. It may be considered that this value should be pretty consistent across fatalities from whatever cause in whatever system. However, the UK Health and Safety Executive has published information on the use of integer multipliers that can be argued to apply to the human value element, based on the concept of dread [3]. Under this concept, the Department for Transport value of prevented fatality may be increased by x2 for fatalities from cancer and x3 for some aspects of railway safety.

2.5 Derivation of the Property Damage values

This is calculated as the direct cost of the damage and destruction to vehicles and other public and private property involved in the accident.

3 Applicability of DfT values to the Rail domain

This section will review the three main value elements described in Sections 2.3 to 2.5 above and discuss how they might carry over to the rail domain.

3.1 Lost Output values

According to the Rail Accident Investigation Branch (RAIB) of the Department for Transport annual report 2005 [7], the persons effected be rail industry accidents within the reporting period were six staff fatalities, ten passenger fatalities (from all causes) and 16 persons on level crossings. Mercifully less than those on the roads. The demographics of this group are not known in great detail, however the accident report summaries given do indicate that two of the 32 fatalities were to children. As noted, six of the fatalities were definitely employed persons, and it is reasonable to judge that the remainders were a cross section of the general public of a variety of ages and employment types.

As such, it is reasonable to judge that the lost output values may be considered broadly comparable between the DfT value and a rail industry value.

3.2 Human cost values

The UK Health and Safety Executive has published information on the use of integer multipliers that can be argued to apply to the human value element, based on the concept of dread [3]. Under this concept, the Department for Transport value of prevented fatality may be allowed to increase by x3 for some aspects of railway safety. These aspects are considered to be those where the victim is considered to have had no control over the level of risk to which they were exposed, and where they received no benefit from taking that level of risk.

Of course it may be argued that the benefit obtained is the change in location for which the train journey was taken, and that the concept of risk on the railways does have a reasonable level of public exposure, so an accident couldn't be a totally shocking event. The six rail staff members do receive an extra benefit of being exposed to risk (their salaries) and they must be considered as being fully aware of the risks.

However, even in light of the above, it is reasonable to judge that the human cost values should be factored up for some aspects of rail safety, but not all. To arrive at an average value for the rail industry, it is considered that the fatal accident prevention value should be double the DfT value.

3.3 Property damage values

The RAIB is mandated to investigate all rail accidents where potential safety lessons can be learned, that involve a derailment or collision which resulted in or could result in a fatality, serious injury to five or more persons, or extensive damage to stock and/or infrastructure [7]. The definition for extensive damage is given as being in excess of €2M [ibid.] (roughly £1.3m).

The 2005 annual report [ibid.] described 100 incident notifications over the reporting period, which led to 17 investigations. Of these four are recorded as causing damage which may be considered as extensive.

N.B. Only one accident report specifically cites the phrase 'extensive damage'. The four descriptions are;

"... extensive track damage…" following a four-mile derailment.

"... significant damage…" to the leading vehicle following a collision with a tractor on a level crossing.

"... damage…" to the train following a collision with a car on a level crossing and a subsequent fire.

"... damage…" to two trams involved in a collision on a single-line section of track.

The actual property damage totals are not recorded, but for the purposes of this paper, it is considered reasonable to sum the damage from these four events as €8M (roughly £4.8m).

Averaging these four damage events over the 17 investigated gives a property damage value per event in the order of £250k. This is a full two orders greater than that included in the DfT value calculation (~£10,000). This is a significant difference and needs careful consideration if the DfT value is to be used in the rail domain.

3.4 Value of preventing a fatal accident in the rail industry.

Summing the components discussed in sections 3.1 to 3.3 gives an overall value for the prevention of a fatal accident in the rail industry of around £2.8 Million (2006 prices).

4 Applicability of the DfT values to the defence industry.

For wider comparison purposes, a consideration of the applicability of the DfT component values to an industry sector outside the transport domain is required. The domain selected for this is the defence industry. The selection has been made because of personal experience, availability of information and recent public exposure of military accidents.

Each year the Defence Analytical Services Agency (DASA) produce a series of formal reports concerning military fatalities and their causes [1]. The data is provided across several demographics, one of which is the main cause of death. These causes are limited to Accidental, Disease, and those due to Violence (killed in action or from wounds in action). As far as this paper is concerned, only those relating to accidents are appropriate for consideration.

In 2006, 95 deaths from 76 incidents were recorded as being caused by accidents, this accounted for 50% of all deaths in the regular Armed Forces. 59 were recorded as being related to land transport, 36 were described as relating to 'Other Causes'.

4.1 Lost output values

For lost output values the demographic of military fatalities is not at all consistent with that used to construct the average DfT values. All the military fatalities happened to employed persons of employable age (i.e. no children). This indicates that military personnel are already well through their potential full contributions of output value, so would have less to output over their lives had they continued living.

As such, for this specific sub-set of the population, the loss of output value should be somewhat lower, perhaps by as much as 50%.

4.2 Human values.

Utilising the DfT method of assessing the willingness-to-pay concept to develop a human cost for military personnel also appears to be unsatisfactory. There is evidence from the HSE [3] that the public is not insensitive to the cause and circumstances of an injury or fatality. This sensitivity to the causes of death has led to public aversion or dread of particular, specific causes of death, e.g. death by radioactive substances.

This discussion has been taken further and it should be entirely possible to argue a reduction in this value element [4] because the risk of fatality is already accepted to a certain extent by the employee and their relatives and friends. It may be argued that this is the case in the military environment where a service person has already accepted that they will be exposed to fatality risks. Every accidental fatality is a tragedy, but the public feeling of dread and the perception of a military service person being killed are probably not the same as for a child being run over and killed by a lorry.

In light of the above argument, it is considered appropriate to reduce the DfT human cost component by 50%.

4.3 Property damage values.

The property damage component is highly likely to follow a similar argument to that for the rail industry example. Several of the military accidents recorded by DASA [1] include significant equipment loss – aircraft and vehicle destruction. Although the actual value of lost equipment is not recorded, four aircraft were lost or badly damaged in air accidents during 2006. Three of these were fixed wing aircraft and one was a helicopter. There were 15 fatalities and 5 major injuries.

NOTE: The data includes casualties caused by accidents during military operations, but excludes casualties as a result of aircraft losses caused by "hostile action". The major injuries were caused by accidents that happened after the aircrew had taken responsibility for the aircraft.

Previous research reviewing military equipment loss in 2004 [4] suggested a value of £225m for the aircraft losses due to accidents alone during that year. It would seem reasonable to at least maintain that figure for 2006. Averaging this over the 76 incidents involving one or more accidental fatalities gives a property damage value of around £3m per incident. This is three orders greater than the DfT values and becomes the major factor in calculating a total value of preventing a military fatal accident.

4.4 Value of preventing a fatal accident in the defence industry.

Summing the components discussed in sections 4.1 to 4.3 gives an overall value for the prevention of a fatal accident in the defence industry of around £ 3.7m (2006 prices).

5 Requirement for care when using the DfT values

We have already seen that certain components of the make-up of the DfT valuation of benefits of the prevention of road accidents and casualties give rise to applicability difficulties if they are simply transferred between industry sectors. There is one additional concept that this paper will consider that is perhaps more at the core of the analysis than the actual quantification process.

5.1 Definition of an accident.

The Highways Economics Note produced by the DfT does not contain an explicit definition of road accident. There is an assumption that everyone knows what a road accident actually is. Even within the other two domains discussed in this paper the definitions of accident will vary. That in itself is an interesting point, but not for this research (See [5] for a more thorough review of the meaning of key words in the safety domain). Legal judgements on the causes of road accidents and the verdicts on fatalities are of more concern. Consider the following recent report of a road traffic accident:

Mrs B was travelling on the A360 just south of Tilshead when Mr S's car crashed into hers. The inquest heard that Mr S was travelling in the opposite direction to Mrs B, in excess of 60mph limit and had overtaken on double white lines on the blind brow of a hill when the accident happened. A police investigation put the accident down to driver error on Mr S's part. The coroner said "The only lesson in this is for drivers not to overtake against a double white line system on any circumstances – you cause not only your own death but someone else's as well." [6]

The coroner's verdict on Mr S's fatality was death by mis-adventure, and the verdict on Mrs B's was unlawful killing. Neither of the fatalities was judged to be an accident [ibid.]. With two fatalities, this event would have contributed double to the average quantification for the DfT prevention values. This is perfectly fine for the DfT case, because the data and future use of figures is within the same domain. However, the use of non-accident valuations when carrying over the value to other industry areas does not give a real picture of the values relating to that domain's definition and scope of what is meant by an accident in their case. It is not recommended without explicit acknowledgement.

Data of enough fidelity to establish the actual set of road traffic fatality data that has been judged to be an accident has not been identified. This task will form a recommendation for future research work.

6 An additional component for the societal benefits of preventing accident events

One component that is cited throughout industry is that of time – 'time is money' is the famous quote that probably all of us have used or heard used during our careers. But what actually is the value of time? In the three industry domains considered in this paper, time should have a real value. There is a cost to society for delays in the rail network and the road system. There is certainly a real benefit to be had from a battle tempo without delays.

So this is the additional component I am recommending for some allowance in societal value calculations when assessing the benefits of preventing accident events – the value of preventing delay.

Research by the National Economic Research Associates (NERA) has sought to identify a value for time through assessment of rail passenger opinion of the value of their time [6]. Table 4 shows the results of one part of the wider research into a value known as the Societal Rate (for rail industry performance incentives), which shows the value of time in pence per passenger minute on various rail service types for a 50 mile journey.

Service Type	Value of Time (pence per passenger minute delay)
Intercity	68
Regional	50
London & SE peak	56
London and SE off-peak	62

Table 4: Comparison of value of time

6.1 Value of societal delay in the rail industry

The NERA research puts forward three options for deciding on a societal rate for performance incentives – reinstate an older version, reflect the actual costs to society, or have no rate at all [6]. These options are in consideration of the market place of the rail industry, which is a specific objective of that research. In the case of this research, a value of delay may be obtained by taking the average of the NERA researched values, this is around 60 pence per passenger minute.

In the rail industry, accident events cause considerable delay for hundreds, perhaps thousands of people. Indeed the line may be closed for several days or weeks causing extended delays. However, it is considered that after the first delay commuters take the new track circumstances into consideration when planning their following journeys. In doing this, they tend to take time from their leisure time rather than their working time, so reduce the impact on lost financial output. But in the short term – on the day of the accident event, the delay does have an impact.

One of the events investigated by the RAIB [7] does give accurate timing metrics for the closure of a line following an accident event. This particular accident occurred at 05:30 hours when an empty (of passengers) 4-car electric unit was derailed at Watford Junction station. There were no injuries to staff, but some damage occurred to the track which was repaired, enabling the branch to be re-opened by 16:00 that day. The delay to passengers is not recorded, but it would be reasonable to judge that all the trains that day were subject to delays of at least 10 minutes. With perhaps half a million passengers using this line in both directions during the times noted the financial impact of the delay would be of the order of £3m. This is calculated from 10 minutes x 1/2 million passengers x £0.6 per passenger minute.

Rail staff familiar with the track system layout and alternatives do react well and minimise delays to minutes rather than hours. In the road traffic example, the lack of knowledge of alternative routes can lead to extensive delays for many drivers, leading to a higher impact for the delay event.

6.2 Value of societal delay in the road traffic industry

The DfT does not consider the effect of a road closure in delaying travellers and impacting economic output. It is usual for a fatal road traffic accident to be considered as a crime scene until shown otherwise. As such roads can be shut for several hours for the capture of evidence. Multiple alternative routes will be available, but these will increase the journey time of travellers, even those with Sat-Nav equipment, as the alternative routes may become saturated with traffic. Delays of around an hour are not uncommon.

The number of travellers effected is unlikely to be more than those effected by the rail accident event – perhaps of the order of only 5,000 in any one area of the road network.

With these values judged to be in place the financial effect of the delay might be taken to be of the order of £200k per fatal accident event. This is not insignificant compared to the component values already used. A recommendation for further research in this area will be made in order to arrive at a more accurate value of this effect.

6.3 Value of delay in the defence industry

Unfortunately, it is considered that this problem cannot be solved explicitly within the boundary and constraints of this paper. The concept of battle tempo is well known within the services and a reduction or delay in tempo or operation capability due to loss of resource from accident events is an accepted constraint. However the quantification of a monetary value of the benefit from preventing delay in operations has not been made. The determination of an equivalent metric to the transport value of time per passenger minutes does not carry over well, as military operations do not necessarily obey strict pre-planned timetables. A recommendation for further research in the area will be made.

7 Summary and conclusions

This paper has discussed the main components used to develop the value of potential benefits that may be obtained through the prevention of accident events in several industry domains.

It has been shown that 'blind' use of the Department for Transport value of prevented fatality is not always wholly appropriate. It includes components limited to the property damage values associated with road transport only; it contains values calculated from a wide societal group that includes persons below employable age; it includes data values from non-accident events; and it does not consider the impact of delay.

Further research is recommended to identify the sets of road traffic events that are judged as accidents as compared to those that are judged as arising from other causes. Further research is also recommended to establish a more accurate benefit from reducing delay following a road traffic accident. Additional research is recommended in identifying the problem domain and effects of delay in the military domain due to accident events.

References

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Biography

Richard is currently Director of an engineering consultancy specialising in the provision of complex argument assurance cases and safety analyses. He has direct experience of safety case authoring and assessment including multiple risk analysis techniques such as Fault-tree Analysis, FMECA, QRA, HAZOP studies, ALARP arguments and Hierarchical Task Analysis. Richard has over ten years of experience specialising in the areas of Safety Case Development, Human Factors Assessment and the Verification and Validation of Models and Simulations. He has gained his in-depth knowledge in three employment fields – firstly designing, modelling and testing prototype safety systems for the auto industry; then in to post-accident and predictive stress analysis and computational fluid dynamics modelling for on-shore and off-shore oil and gas pipework systems. Finally as evaluation engineer assessing military software and human systems, constructing safety cases and developing an international standard to assist in the verification and validation of models and simulations. His first specialist technical book titled “Safety Cases and Safety Reports – Meaning, Motivation and Management” has just been published by Ashgate Ltd.