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The economic evaluation of heavy vehicle rest areas A new technique?

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Abstract

The provision of well planned heavy vehicle rest areas is fundamental to the efficient and safe operation of interstate freight routes. Over the last five years the Federal Government has championed the use of economic appraisal and cost benefit analysis as an analytical technique to advise on the merit of these road side facilities. As a case study example, this paper will revisit the methods used in undertaking an economic appraisal of a program of heavy vehicle rest areas in Central Queensland during 2012.

Unlike other road projects, considered thought around impact and effect is required not only at the route level but at the link level also. With the main objective of these facilities being largely to do with addressing heavy vehicle driver fatigue and compliance with transport legislation. An approach based on safety, accident history and severity would normally be warranted in order to identify and measure benefits. This paper will also contain a discussion of those additional benefits, especially comfort and convenience and also consequential impacts on productivity.

This paper will then focus on those ways/methods which can be used to strengthen these appraisals, and also consider what sort of data needs would one would expect given the types of economic and social objectives that the jurisdictions are trying to address with these types of projects.

1. Introduction

Since 1970, the national fright task has increased from 27 billion tonnes to 187 billion tonnes[1] with a smaller rate of increase expected over the next few decades. The provision of adequate infrastructure to support road freight transport has been an important though not a dominant political issue. Nationally, a regulatory regime exists covering heavy vehicle driver fatigue. Consequently the public should be assured that adequate facilities are in place to cater for driver needs and requirements to comply with relevant regulations to rest and recuperate. This paper presents a unique perspective on the processes involved in undertaking an economic evaluation of rest areas together with a succinct discussion on those related issues which form the background to this important topic including: growth in heavy vehicle usage/freight task; fatigue; rest areas characteristics and also willingness to pay (WTP). In doing so, a project case study has also been presented to highlight the practical application of adopting these evaluation techniques.

[1] (BITRE Estimates 2013)

2. What is a heavy vehicle rest area?

In order to understand a little more about rest areas and to provide some clarity to the economic evaluation, a brief summary of key technical documentation has been presented below.

2.1 National guidelines for the provision of rest area facilities

All state road authorities adhere to technical standards in regard to the planning and construction of rest areas. As a way of addressing various inconsistencies inherent in technical standards among jurisdictions the NTC has embarked on a project to address the differences across jurisdictions and also to arrive at national definition of a rest area. A key focus of the 2005 national guidelines was to do with consistency in the frequency, location and provision of these facilities.

Three majors categories of rest areas have been identified for the purpose of this work:

- Major rest area (for longer rest breaks with 15 or more parking bays)
- Minor rest area (for shorter rest breaks with up to 15 parking bays)
- Truck parking bay (for short purpose based stops, with up to four parking bays).

As a general rule, major rest areas are not located more than maximum intervals of 100 km's, minor rest areas, 50 km's and truck parking bays 30 km's. Rest area facilities as a minimum should have all weather pavements, shade, rubbish bins, separate parking for light and heavy vehicles, sheltered areas and tables and benches.

2.2 TMR road planning and design manual

In the case of Queensland, the TMR road planning and design manual provides some guidance around the attributes of rest areas. These include:

- Capacity for up to six vehicles
- Sealed
- Basic shade
- Signage
- Other facilities[2].

Importantly, from a planning perspective, rest area guidelines suggest that rest areas should be located at intervals of not more than every 80 kilometres on major freight links/routes. Rest areas are usually planned for remote and northern parts of the state and away from commercial developments, service stations and other service centres that would negate the need for such dedicated facilities. In addition, the Queensland Roadside Amenities Strategy (1999) also contains minimum standards in regard to rest facilities.

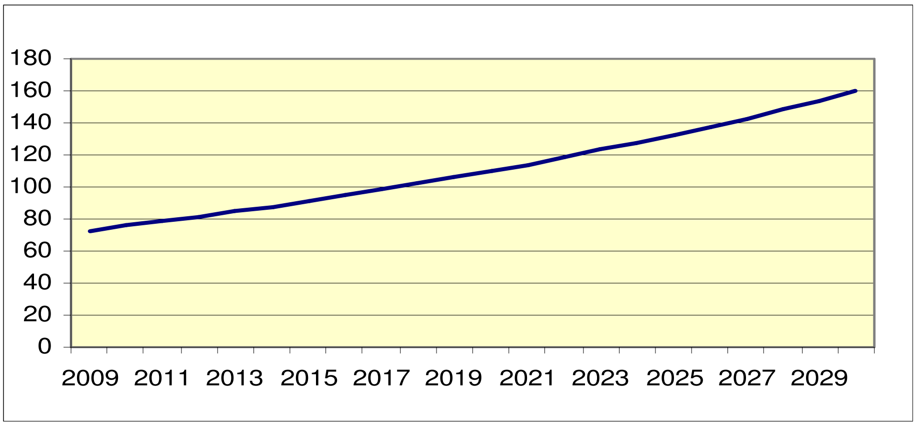
[2] (A typical facility would include shelter, tables, toilets and water)

3. A closer look at heavy vehicle trends

Given the important role that rest areas perform in (1) providing critical support to, and (2) enabling of, the national freight task. A close look at the trends in heavy vehicle use and freight may be warranted. Overall, Australia's reliance on heavy vehicles is quite significant performing an important function in regards to the economic development of rural and remote communities. Current projections indicate that interstate growth in heavy vehicle use is expected to be quite strong over the medium to longer term. Graph 1 indicates forecast growth in interstate road freight through to 2030.

Trends in heavy vehicle usage across the country show no signs of decline. If recent growth in the national freight task provides any such indication, heavy vehicle use on key freight routes will remain quite strong over the next 20 – 30 years. The data presented in the Graph 1 below indicates consistent overall growth in the national freight task and with it strong jurisdictional interest in the continued development of a comprehensive regional network of well maintained rest areas. The project case study presented at the end of this paper includes heavy vehicle AADT / growth as an input used to calculate benefits associated with the construction of rest area projects.

Graph 1: Forecast of interstate road freight task, (billions of tonnes per kilometre) 2008 - 2030



Source: Reproduced from BITRE Interstate Road Freight Forecast, 2008-2030

4. The role of fatigue

The identification and measurement of benefits flowing from the construction of rest areas requires considered thought around the issue of driver fatigue. Although, it is well documented that there is difficulty in ascertaining the exact proportion of crashes caused by fatigue[3], many studies have identified correlations between rest area distances and the rate of single vehicle collisions[4]. The overall impact of fatigue on Australian roads is quite significant and has serious consequences. Fatigue contributes to around 20% - 30% of all deaths on the road being as much a contributor to the road toll as speeding or drink driving[5].

[3] (Austroads AP T95/08, P18)
[4] (University of California Berkeley 2009, p12)
[5] (QUT 2011)

4.1 Definitional issues

Uncertainty exists within transport jurisdictions around the definition of driver fatigue. Although there are some studies both within and outside Australia that have made various attempts to define fatigue. Identifying fatigue related crashes remains difficult by the absence of a universally accepted definition[6]. Among international jurisdictions, the United States National Highway Traffic Safety Administration defines fatigue as the progressive withdrawl of attention to the tasks required for safe driving[7]. Alternatively, collision data collected by the California Highway Patrol, appear to adopt a more expanded definition of fatigue.

A study undertaken by Dobbie (2002) surveyed Australian accidents over a nine year period from the Australian Transport Safety Bureau crash database. The study proposed an operational definition of fatigue and included the following attributes:

- Single vehicle crashes occurring during critical times midnight - 6.00 a.m. and 2:00 - 4:00 p.m
- Head on collisions where there was no overtaking at the time of the crash.

Those crashes excluded from this definition include:

- Those crashes with speed limits under 80 kilometres per hours
- Those crashes involving pedestrians
- Those crashes where the driver was unlicensed or under the influence of alcohol.

Although, this definition of a fatigued driver is somewhat limited in scope, this study has found that those crashes where the heavy vehicle driver was fatigued represented 17% of total crashes. One of the more important findings from this study is that the risk of dying from a fatigue related crash in rural areas of Queensland being around 13.5 times higher than the national average.

4.2 The role of rest areas in addressing heavy vehicle driver fatigue

To date little research exists to help ascertain the proportion of crashes caused by fatigue due to drivers choosing to either drive for longer periods without a rest or because of a lack of adequate rest opportunities being provided. This task has also been made more difficult due to the large number of parameters. Furthermore, due to the subjective interpretations and opinions frequently offered by the investigating police officer, the role of fatigue in accidents is highly underestimated[8].

In August 2006, Austroads commissioned ARRB to audit a limited sample of rest areas located on the national road network in order to assess compliance with the (previously mentioned) national guidelines. In doing so, a literature review was undertaken pulling together relevant research focusing on the role of driver fatigue in reducing accidents. In summary this work was quite comprehensive and thorough in surveying all relevant literature[9]. Fatigue has been recognised as a significant problem to road safety and is a major contributor to many heavy vehicle crashes[10].

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[6] (University of California Berkeley 2009, p7)
[7] P (Austroads AP T95/08, P18)
[8] (Austroads AP T95/08, P18)
[9] The 2007 Audit produced by ARRB/Austroads presented an extensive list of research from around 1988 to around 2005 focusing on this topic. A presentation of this work can be found in the Austroads report.
[10] (Austroads AP T95/08, P18)

Australian based studies indicate fairly consistent results on this subject. Evidence suggests that around 5-20% of all crashes in Australia are fatigue related[11]. Three key factors are believed to influence fatigue they are, lack of sleep, time of day and time on task. Separate research has also been undertaken at the state level and on particular links for example the Hume Highway in Victoria and has revealed similar conclusions. Similar findings can also be drawn looking at the role of fatigue in overseas jurisdictions. International research confirmed the Australian findings, suggesting the influence of driver fatigue in 13% to 41% of all heavy vehicle crashes, although the definition of fatigue does differ[12].

In terms of fatalities, Australian literature suggests that between 4% and 30% of fatal heavy vehicle crashes involved heavy vehicle driver fatigue. Similarly, between 6% and 42% of all heavy vehicle crashes could be linked with driver fatigue[13]. Allowing for the underreporting of crashes, the NTC have also advised that those fatal crashes where the heavy vehicle driver is fatigued represents around 13% of all fatal crashes.

4.3 Methodological challenges

The connection and causal relation between the planning and construction of rest areas and the consequential reduction in fatigue related crashes is largely unknown and is one field which would benefit from further research. An issue still remains with causation. There is some uncertainty as to what type of accidents will be addressed by the construction of a rest area. Matching crashes, rest area use and the length of time behind the wheel with other likely crash factors further complicates the task. Applied research into the relationship between the provision of rest areas and crash reduction is needed, particularly in relation to heavy vehicles. Other areas of research where decision/policy makers need to be better informed relates to the potential usage of the facilities. Industry cooperation would be needed in this case to help determine the marginal propensity of truck drivers to use rest areas. Determining if a driver involved in a crash would or would not use a rest area even if it was available is currently a key problem. These issues will be dealt with in the next section.

Two major US based studies provide groundbreaking findings in relation to the link between fatigue and the construction of and location of heavy vehicle rest areas in California. Out of a selection of collisions occurring between 1995 and 2005, fatigue collisions account for more than 1.3 % of total collisions in California. The number of fatigue and non fatigue collisions declined significantly downstream of rest areas. It was also found that the number of fatigue collisions tended to decrease immediately downstream of rest areas while suddenly increasing 30 miles from rest areas, while non fatigue collisions remained the same.

The study also investigated fatigue collisions which were downstream of informal rest areas described as shoulders adjacent to ramps where otherwise formal rest areas did not exist. The findings of this study demonstrated that on average, informal rest areas were less safe than formal rest areas[14]. Another US based study has concluded that there is a strong correlation between the spacing and sequencing of rest areas and the incidence of fatigue based collisions. The greater the distance between rest areas, the higher percentage of single vehicle truck crashes[15].

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[11] (Austroads AP T95/08, P18)
[12] (Austroads AP T95/08, P3)
[13] (Austroads AP T95/08, P28)
[14] (University of California Berkeley 2009, p7)
[15] (Taylor and Sung , 2009)

5. Rest area benefits

Undertaking a cost benefit analysis usually requires a firm grasp on the benefits that the project generates, this is more than applicable in relation to the evaluation of rest areas. The planning and construction of rest areas is usually justified based on their impact on road safety. From a policy perspective rest areas also generate efficiency and productivity outcomes, the efficient and seamless movement of freight from origin to destination being a national priority. A strong argument can be made that those important safety and other counter measures which are specifically designed to address safety concerns also contribute to advancing the movement of freight around the country and overseas. Additional benefits relate to driver comfort and convenience with drivers now being able to use a facility that would not otherwise exist.

The existing literature and related documentation associated with the main benefits of rest areas is relatively scant. The literature touching on this issue reported difficulty in determining with any certainty the types of crashes that rest areas prevent, or whether drivers would use the facilities provided[16]. The previously discussed national audit of rest areas carried out a review on this topic. For the purposes of this paper, it can be deduced that benefits from rest areas fall into three categories:

- Road Safety
- Driver Comfort and Convenience
- Productivity.

The benefits derived from the construction of rest areas do not emanate from the facility itself rather from the resulting safety impact on the respective road section/link. Hence the project analyst is not simply evaluating a single facility/project site but in fact an entire link and the resulting impact on road safety. As a consequence the economic evaluation of rest areas generally requires some considered thought around impacts and effects both at the route level and also the link level.

5.1 Causation / driver behaviour

As discussed in the previous section, an integral concept in relation to the planning and evaluation of rest areas assumes that their construction merely allows drivers to comply with relevant legislation. As already raised, whether drivers in fact use the rest areas provided remains an important question. A point of discussion is that rest areas are an enabling, not a delivering intervention. Without the provision of adequate rest areas drivers have the option of either not stopping as required, or stopping somewhere unsuitable or in a potentially unsafe location. The project analyst is therefore forced to assume that rest area facilities serve the purpose that they were intended for and heavy vehicle drivers in fact comply with relevant legislation and use the facilities provided.

6. Willingness to pay

WTP essentially involve using individual preferences to place a value on investments in infrastructure, safety countermeasures, initiatives etc. Estimates of willingness to pay are based on public survey or analysis of accepted compensation from voluntary reduction of risk[17]. Austroads has been at the forefront of moves to adopt WTP methodologies for use in

[16] (Austroads AP T95/08, P18)
[17] (Mabbott, Swadling 1998, Page 3)

CBA in the economic evaluation of projects. The existing method used to value accident costs is the alternative human capital technique and is based on dollar values of past accidents and essentially attempts to measure the costs through the individual's loss of earnings. The ex-ante or WTP measures the amount the individual is willing to pay to reduce the probability of death or injury.

The technique has particular application to the economic evaluation of rest areas and represents a unique opportunity to measure project benefits. Comfort and convenience is a key benefit category associated with the construction and upgrade of rest areas. Having available a set of WTP unit values when measuring benefits would represent a more thorough approach to undertaking the CBA. It is understood as of writing that informal arrangements currently exist among transport jurisdictions to use preliminary WTP data for use in safety based evaluations. The example provided later in this paper will demonstrate the application of the WTP approach.

Incorporation of the case study[18]

7.1 Project details

This project case study has been presented to illustrate the practicalities of evaluating proposals to both, construct and also upgrade rest areas. Incorporating a proposal to construct three new rest areas and upgrade five existing rest areas, all project sites were located in and around central and south-east Queensland. This economic evaluation has been undertaken at the program level and without any close degree of detail. The inputs to this CBA are based on information that can be derived from TMR traffic/accidents and other relevant databases. Please note this was not a detailed project level CBA. Tables 2 and 4 provide the summary details for the complete program of works. A discussion of the CBA results has been provided in Section 7.5.

7.2. Proposals to construct new rest areas

7.2.1 Approach and methodology

A customised spreadsheet[19] has been used to undertake the necessary calculations for this CBA. A key input to the spreadsheet, the crash reduction rate of 3.7%, has been chosen based on relevant local studies and also other fatigue related research discussed earlier in this paper[20].The WTP elements of this economic evaluation was used in a complementary way, to monetise driver comfort and convenience. A list of input data has been provided in table 1 [21].

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[18]The following project case study forms part of a program based funding submission to Infrastructure Australia.
[19]A customised spreadsheet based calculator has been used to calculate benefits for these projects. Initially developed internally by TMR as a tool to assist with the economic evaluation of rest areas, the spreadsheet contains inputs in relation to fatigue, heavy vehicle crash data and an assumed crash reduction rate as inputs to calculate benefits.
[20] A reduction factor of 3.7 % was chosen based on the findings of a major study by the transport research board in the United States in 1989.
[21] Bold figures indicate that the relevant input data is not able to be adjusted by the user.

Table 1: CBA data inputs, new rest areas

CBA inputs	Warrego	Flinders	Cunningham
Heavy Vehicle Crashes	29	31	168
Fatigue related (%)	20	32	15
No. Fatigue related crashes	6	10	26
Years of Data	7	7	7
No. Fatigue related (Yearly)	**0.85**	**1.42**	**3.71**
CPI (%)	**6**	**6**	**6**
Unit Cost (2010, $)[22]	**265,215**	**265,215**	**265,215**
Crash Reduction per 100km (fatigue related) (%)	3.7	3.7	3.7
Heavy vehicle AADT	**716**	**170**	**1,427**
WTP per stop ($)	1.00	1.00	1.00
Days in Year	365	365	365
WTP Year 1	**261,519**	**62,093**	**521,212**
Traffic Growth Rate (%)	8%	3%	2%
Capital	600,000	1,500,000	2,800,000
Discounted capital cost (7%)	**560,748**	**1,401,869**	**2,616,822**
Discounted capital cost (4.4%)	**576,923**	**1,442,308**	**2,692,308**

7.2.2 The base case

The base case can be explained by higher than average (fatigue induced) heavy vehicle accident rates on each of the three highways/links. The base case is also represented by a reluctance of drivers to maximise travel time on these freight links or perhaps even not to travel at all given the lack of rest facilities.

7.2.3 The project case

With the construction of new rest area facilities on each of the three highways the project case can be distinguished from the base case by a reduction in fatigue related accidents and the additional capability of drivers to optimise their travel time. Given that drivers now have ample opportunity to rest and recover and hence comply with necessary legislation, this analysis has assumed that fatigue heavy vehicle related accidents decrease by around 3.7 precent.

[22] The 2010 unit value ($265,215) given in table 1 has been adjusted by the CPI % to arrive at a 2012 unit value which was used for the calculation of benefits.

Table 2: Project case details (new rest areas)

Project Name	Region	Project Type	Capital Expenditure ($)
Cunningham Highway	Southern Queensland	new rest area	2.8m
Flinders Highway	North West Queensland	new rest area	1.5m
Warrego Highway	Southern Queensland	new rest area	600k

7.2.4 Key assumptions

- The rest area calculator (TMR spreadsheet based tool) has been used to undertake the economic evaluations for these projects
- June 2012 prices have been applied to all benefits and costs
- Fatigue related crashes have been assumed to reduce 3.7% per 100km (TMR, 2008)
- A discount rates of 4 percent has been applied
- The evaluation period is 26 years based on 1 year of construction and twenty five years of benefits.

Table 3: CBA results

	Warrego	Flinders	Cunningham
Discount Rate	**4%**	**4%**	**4%**
Capital Costs	576,923	1,442,308	2,692,308
Benefits	5,822,051	2,860,527	13,098,591
Crash Benefits	116,180	61,755	909,318
Comfort & Convenience Benefits	5,705,871	2,798,772	12,189,272
NPV	**5,245,128**	**1,418,220**	**10,406,283**
BCR	**10.09**	**1.98**	**4.87**

The CBA results indicate that with the exception of the rest area facility located on Flinders, all projects are considered viable at the prescribed discount rate.

7.3. Proposals to upgrade to existing rest areas

7.3.1 Approach and methodology

In relation to the five proposals to upgrade and flood proof existing rest areas, the main benefits are to do with flood proofing the immediate surface area of the existing rest area facility. Other benefits might include reduced dust impacting on nearby residential communities. Consequently, the technical approach for this evaluation relies on WTP during those days of the year when the project site is flooded. In the absence of actual (flood) road closure data for each project site, there was little if any merit in devising an accident based approach to the evaluation. It was assumed therefore that these facilities were closed during those rainiest months of the year (December/January), or for around 60 days per year[23]. Heavy vehicle AADT on each of the respective links was used as a proxy for demand for each site. Table 5 shows the results of the analysis. Consequently, WTP was used solely as a means to value benefits in this analysis.

7.3.2 The base case

The base case can be characterised by the inaccessibility of heavy vehicles not being able to access and thereby properly use the rest areas during those persistent and rainy months of the year (December/January)[24]. Under these circumstances drivers are inconvenienced by being forced to divert to other sites in alternate locations or pull over on the side of the road.

7.3.3 The project case

With proper flood proofing in place at all of the rest areas facilities, the project case can be simply characterised by heavy vehicles having unrestricted and full access to those existing rest area facilities all year round.

Table 4: Project case details (rest area upgrades)

Project Name	Region	Project Type	Capital Expenditure ($)
Ivanhoe (Landsborough Highway)	Fitzroy Region	rest area upgrade	500k
Morella (Landsborough Highway)	Fitzroy Region	rest area upgrade	400k
Colloseum Creek (Bruce Highway)	Fitzroy Region	rest area upgrade	150k
Gavial Creek (Bruce Highway)	Fitzroy Region	rest area upgrade	350k
Caltex North Rockhampton (Bruce Highway)	Fitzroy Region	rest area upgrade	550k

7.3.4 Data inputs (rest area upgrades)

The calculations behind the WTP approach can be represented by the simple formulae explained below.

WTP per day, per heavy vehicle = $1
Heavy Vehicle AADT = X
Days of outage per year = Y

Annualised ($) Benefit per rest area therefore = [(X * Y) * $1]

[23] A willingness to pay value of $1, per heavy vehicle, per day of closure for each affected facility was used to value benefits.
[24] Potentially, monthly rainfall data could have been collected for each project site from the Bureau of Metrology. However to simply this analysis, it has been assumed that each project site was closed for two months per year (January/December).

Table 5: CBA results, rest area upgrades

	Ivanhoe		Morella		Colloseum Creek		Gavial Creek		Caltex North Rockhampton	
Discount Rate	**4%**	**7%**	**4%**	**7%**	**4%**	**7%**	**4%**	**7%**	**4%**	**7%**
Project Costs ($)	480,769	467,290	384,615	373,832	144,231	140,187	336,538	327,103	528,846	514,019
Project Benefits ($)	377,560	259,022	351,229	237,652	2,107,977	1,487,317	3,672,972	2,519,809	1,530,074	1,094,893
NPV ($)	- 103,209	- 208,268	- 33,386	- 136,180	1,963,746	1,347,130	3,336,433	2,192,707	1,001,228	580,875
BCR	0.79	0.55	0.91	0.64	14.62	10.61	10.91	7.70	2.89	2.13

7.3.5 Key assumptions

- The evaluation period is 26 years based on 1 year of construction and twenty five years of benefits
- June 2012 prices have been applied to all benefits and costs
- Discount rate of 4% and 7% have been applied
- Comfort and convenience benefits have solely been measured to assess upgrade projects (TMR, 2008)
- Safety and comfort & convenience benefits have been utilised to assess new rest areas (TMR, 2008)
- WTP has been valued at $1 (TMR, 2008)
- Fatigue related crashes have been assumed to reduce 3.7% per 100km (TMR, 2008)
- As a minimum, 15 minute rest breaks have been assumed every 4 hours (TORUM Act, 1995)
- Rest areas are assumed to be located every 80km along the link

7.5 Discussion of CBA results

Overall, the analysis revealed a wide range of results. Not surprising, of the projects generating negative results (Flinders) also recorded relatively low heavy vehicle AADT at 170. This combined with relatively high capital costs would largely explain this project's marginal results.

Of the proposals to upgrade rest areas, both Gavial Creek and Colloseum Creek exhibited quite positive results largely because of the assumptions around Heavy Vehicle AADT and WTP. Conversely, both Ivanhoe and Morella recorded negative results mainly due to relatively low heavy vehicle AADT on the Landsborough Highway where these two project sites are located.

The very high BCRs recorded in some cases, for example 10 for the new rest area on the Warrego Highway and also 14.6 for upgrading an existing rest area at Colloseum Creek are most likely as a result of relatively low capital costs (600k and 150k respectively) for these projects.

The other striking feature of the results is that comfort and convenience accounts for larger share of overall benefits. This can be explained due to comfort and convenience being a function of AADT whereas crash benefits are a function of the crash rate and also accident costs.

8. Conclusions

This paper has provided a unique insight into each of the steps associated with the economic evaluation of the construction and upgrade of heavy vehicle rest areas. A good appreciation and understanding of several key concepts is quite useful when undertaking an exercise such as this one. This paper has started with a brief discussion of several important issues including: technical standards for rest areas, growth in the interstate freight task and trends in heavy vehicle usage; road safety/driver fatigue and also WTP. The connections and causal relationship between crash reduction and the construction of well planned/located rest areas is one area in need of further research. This paper has also offered a practical example where the approach has been recently applied in a funding submission by TMR to Infrastructure Australia. Although this economic evaluation has been undertaken at the program level and as such lacks the degree of detail normally associated with the evaluation of road projects. The principles demonstrated herein would appear go some way in establishing a framework to evaluate these unique infrastructure challenges.

Acknowledgements

This paper could not have been produced without the dedication and contribution of a number of colleagues over several years including Ben Ellis now at Deloitte Access Economics for producing the first CBA for a TMR submission for rest areas in 2008 and more recently Wayne Davies, senior economist CBA team for producing and testing new CBA spreadsheet models specifically designed for this purpose.

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