THE DUBLIN PORT TUNNEL: A COST-BENEFIT ANALYSIS

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An ex-post *cost-benefit analysis has never been completed on the Dublin Port Tunnel. Simon Rattigan rectifies this problem in this essay by undertaking his own cost-benefit analysis. His conclusions are radically different from the official estimates of costs and benefits for the tunnel. This highlights the need for more realistic planning and greater accountability in public sector investment.*

Introduction

The National Roads Authority (NRA) states that since public sector investment resources are scarce, the Government is 'concerned with securing value for money from investment expenditure' (NRA, 2008: 35). Thus Cost-Benefit Analysis (CBA) was established as 'the most important technique for project appraisal in the public sector' (Mulreany, 2002: 1). However, even though the NRA produced a very sizeable document (Performance Appraisal Guidelines, 2008) outlining the project appraisal guidelines for public sector investments, an *ex-post* CBA has not been conducted for the Dublin Port Tunnel (hereafter 'the tunnel' or 'DPT'). This is rather surprising considering it cost a total of €752 million to the exchequer.

In this paper, the rationale for CBA as a tool for project appraisal in the public sector will be explained and then a CBA of the Dublin Port Tunnel will be prepared. The observed benefits will be weighed against the costs and discounted to establish a Benefit/Cost ratio and the Net Present Value (NPV) over the 'appraisal period'. This will then be compared to the initial figures presented in the Environmental Impact Statement 1998 (EIS) circulated prior to the project commencement, which justifies the tunnel with very favourable cost-benefit predictions. For the purpose of this paper, the effects of the Heavy Goods Vehicle (HGV) Management Strategy will be included as part of the DPT, as the DPT has enabled the removal of HGVs from the city centre.

Cost-Benefit Analysis

This is an extremely important tool for project appraisal, especially for 'sectors that do not have a marketable output' (NRA, 2008: 35). CBA is an application of welfare economics (Mulreany, 2002) and, as such, consumer surplus is used to measure the benefits of road investment. This is due to the fact that 'transport is not usually an end product in itself… it permits other activities to be undertaken' (Barrett, 1982: 28) and therefore CBA substitutes 'social benefit for the revenue of the firm' (ibid.: 29). Clearly then, it is important that overall gains to society are evaluated in the CBA and a project must satisfy the Pareto optimality condition: 'if we can find a way to make some people better off without making anybody else worse off, we have a Pareto improvement' (Varian, 2006: 15).

Barrett and Mooney (1984: 22) state that 'highway investments have quantified three main benefits: time savings, accident reduction and vehicle cost savings' and similarly, this paper finds these benefits with regard to the tunnel. The valuation of costs is relatively straightforward because they reflect market prices (Mulreany, 2002), and in this paper it is assumed that they are competitive. However, since market prices do not exist for the aforementioned benefits, shadow prices are used to reflect social prices. In this paper shadow prices are taken from the NRA's project appraisal guidelines document (the 'Project Appraisal Guidelines', Appendix 6 'National Parameters Value Sheet', NRA, 2008 - hereafter referred to as 'Appendix 6'), which themselves extend from the COBA computer programme manual (2004).

The Dublin Port Tunnel

Dublin City Council states that, while the NDP gave financial assistance for the 'preliminary design package [of the tunnel] as part of the Cohesion Fund of around 80-85% of this expense, the contract itself was funded entirely by the exchequer'. The overall project cost was €752m which is significantly higher than the initial EIS estimate of €215m (converted from Irish pounds in 2002 prices) (Dublin City Council, 1998a). The project is a 5.6 km underground dual carriageway, and the entrances to the tunnel are at the East Wall Road in the North Port and at Santry, creating a direct link between the congested port area and the M50 outer ring road. Construction lasted from June 2000 until December 2006.

Objectives

The objective of this project was to create a 'vital strategic corridor… ultimately for the benefit of the national economy' (DCC, 2008c). The beneficial effects would therefore stem from a dramatic reduction in the number of HGVs in the city centre and residential areas. As a result, there would be time savings on journeys for cars in the city, accident cost savings due to safer conditions, and vehicle cost savings due to lower journey times. While these are 'the quantified benefits from road investment' (Barrett and Mooney, 1984: 33), other environmental effects such as air quality, noise levels and the impact on the physical environment could be observed.

Money values will be attached to the benefits (where applicable), and they will be listed alongside the costs while comparing the time streams of both (Barrett, 1982: 33). For the purpose of this paper, sensitivity tests will be omitted in preparing the CBA.

Accident costs

'The cost of injuries is estimated from hospital and other medical data and from the loss of output while the patient is undergoing treatment' but it is not possible to establish the cost to the victim in the case of a fatality, so this measure is therefore imperfect (Barrett and Mooney, 1984: 23). Nevertheless, accident costs will be taken from Appendix 6 as shadow prices (NRA, 2008). Appendix 6 shows that there are 0.06 fatalities per accident on motorways compared to 0.045 on two lane single carriageways and 0.032 on dual carriageways. Hence, accident severity is greater on motorways, but 'accident rates are lower' (Barrett and Mooney, 1984: 26) – from Appendix 6, a probability of 0.037 per million vehicle kilometres is obtained. However, with the DPT (and the HGV ban as part of the HGV Management Strategy) traffic is removed from the city centre. As a result there are more vehicles on the M50, which has a lower accident probability, but such an accident is likely to be more severe. The greater severity of impact means a higher cost per accident (ibid.: 27).

For this calculation, the same methodology as Barrett and Mooney (1984) will be utilised. There is limited data regarding traffic flows involving the tunnel so the following analysis is based on various assumptions. Using aggregated data from the DPT website and calculations based on Dublin City Council information (DCC, 2007), approximately 8,200 HGVs use the tunnel daily. Therefore the assumption is made that 8,200 trucks will use the M50 from junction 1 to junction 9 that otherwise would not have taken this route. This journey is 18 kilometres and therefore generates 53.87 million vehicle kilometres per year.[1] The proportions of accidents are 0.09 for death and 0.169 for a serious injury (NRA, 2008) and thus the motorway accident rates are 0.00333 deaths and 0.006253 serious injuries per million vehicle kilometres. Therefore there will be 0.1794 deaths and 0.3368 serious injuries per year that will cost €377,025 at 2002 prices

It has been aggregated from the data (DCC, 2007) that 82.4% of all HGVs have been removed from the city centre area. In 2004 HGVs accounted for 21.4% of the 28 fatalities in Dublin City and 8.5% of the 1,109 injuries (NRA, 2004), and using this as a year of reference, the removal of the above proportion of trucks will save €8,507,346 in the cost of fatalities and €1,511,524 in the cost of serious injuries: in total, a reduction in costs of €10,018,870. Therefore the annual net saving in accident costs from utilising the Dublin Port Tunnel is €12,304,619 (2002 prices). And 'the accident rate reduction will more than compensate for the higher average cost per accident on motorways than in urban areas' (Barrett and Mooney, 1984:27).

Time savings

These are the 'largest benefits of most transportation projects' and the 'key assumptions are that the value of a person's output is at least equal to the cost of employing him or her and that a saving in time will allow production to increase by a corresponding amount' (Mulreany, 2002: 10). Following from this, work and non-work travel times are valued differently, and NRA input values are utilised here. Examined below are the time savings that materialise for motorists in the city area as a result of the removal of haulage vehicles.

The volume of traffic flows has been recorded (NRA, 2004) in various areas throughout the city and these figures themselves indicate the roads most travelled on. The most recent data relates to the year 2004 and thus an estimate of traffic volume reduction from the tunnel is derived from these figures. On average, 31,644 vehicles travel though these various 'main' routes and 10.7% of this is accounted for by HGVs (NRA, 2004). Using traffic forecasts (NRA, 2003) this volume will increase by 5.6% to 33,416 vehicles daily in 2006. There is no current or historic data available for journey times within the city and more specifically, no data relating to time savings as a result of the removal of HGVs in these areas, therefore the following analysis is be based on certain assumptions.

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[1] 8,200 x 18km x 365 = 36.87m km

Category	People per day	Time Saved (hours/day)	Value of Time (€/day)	Annual Savings (€000)
Work	4,348	742.4	22.2	6,015.7
Non-work	41,770	7,131.6	6.35	16,529.3
	46,118	7,874		22,545

Table 1: Time savings from the Tunnel (2002 prices in euro)

According to the NRA, one HGV is equivalent to 2.5 'passenger car units' (NRA, 2008); each HGV removed will therefore be worth 2.5 cars. Accordingly with the removal of 82.4% of HGVs as noted above, travel times within the highly used city areas will be reduced by 18.9%. Therefore 30,469 vehicles should have lower journey times due to the tunnel. Taking NRA vehicle proportions by categorisation and vehicle occupancy rates, it is estimated that over 46,100 people will save time on journeys. It is difficult to calculate actual journey time savings for these motorists because of the vast variety in their routes and journey lengths (surveys would be useful in this regard); therefore based on anecdotal evidence, the assumption is made that the average journey time in the city between 08.00 and 20.00 is one hour. It is also assumed that 71% of the daily traffic total is accounted for between 08.00 and 20.00 and that journey times outside this period are two-thirds of those within it (forty minutes), as in Barrett and Mooney (1984). Therefore 32,744 vehicles (71% of traffic) save 11.34 minutes and 13,374 (29%) save 7.56 minutes daily. In total 46,118 people will save 7874 hours daily, and using values of time savings in Appendix 6 (NRA, 2008), the estimate annual value of savings is €22.545m.

These time savings may be overstated because the relevant NRA data relates to 5-plus axle vehicles, whereas the DCC have stated that 'more than 1,700 four-axle trucks use routes in the city each day' as these are not yet banned (Cooke, 2008). This may give rise to imprecise results but for the purpose of this paper the above serves as a reasonable estimate.

Vehicle Cost Savings

These savings are made through differences in levels of fuel consumption that arise from a road project. Below is an analysis of additional costs to HGVs using the tunnel and savings to those remaining motorists in the city. It is estimated from the National Spatial Strategy and the NRA (2003) that there are approximately 511,789 cars in County Dublin (2006), 5.9% of which travel through the city centre daily. Therefore, of the estimated 29,980 million car kilometres in Ireland for 2006, 1,769m of these occurred in the city centre. A source of overstatement would arise if, for simplicity, fuel savings are directly equated to traffic volume. Therefore, (somewhat arbitrarily) the resulting benefits will be reduced by half, since distances travelled are assumed to be constant irrespective of the volume of traffic. Therefore with a reduction in passenger car units of 18.9% by the tunnel, just over 30,000 vehicles will save 344m kilometres. Using NRA (2008) vehicle operating costs this will amount to €20.862m annually,[2] and adjusted to €10.431m (in 2002 prices).

However, many trucks must now travel greater distances than they otherwise would have – 8,200 trucks now use the tunnel and the M50 to reach the Red Cow roundabout that ordinarily would have driven through the city. This journey is 24km compared to the previous route of 13km though the city, therefore 8,200 trucks must now travel an additional 11km. While the Irish Road Hauliers Association (IRHA) claim that this costs an additional €10m per year (Cooke, 2008), this paper calculates an overall additional cost to hauliers of just over €5.4m.

Category	Number per day	Extra Kilometres	Fuel Costs (cent/km)	Annual Cost (€000)
LGV	4,346	47,806	6.987	1,219.3
OGV1	1,319	14,509	16.191	857.5
OGV2	2,535	27,885	32.866	3,345.1
	8,200	90,200		5,421.8

Table 2: Additional fuel costs to HGVs (2002 prices in euro)

Overall, subtracting the additional cost to hauliers from the savings to the remaining city road users, there is a net saving of €5.009m per year. These benefits are the smallest of those enjoyed by the DPT.

Costs

The costs of an individual road investment are those that are required 'to establish, maintain and operate a project' (Georgi 1973:19) and the NRA split these project costs into two categories: investment costs and operating costs (NRA, 2008: 44). The former includes construction, land acquisition and labour while the latter relates to the cost of maintenance. In 1998 before construction, an EIS appraisal summary announced a total cost outlay of only €215m for the DPT over a 43 month period approximately. Admittedly, the ultimate tender price was for €457m but the

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[2] 7.0864m km [344 x 0.0206] x 6.98772640 cent/km + 336.8792m km [344 x 0.9793] x 5.151189102.

total cost came to €752m taking sixty-six months to complete, opening three years later than intended. This begs the question as to why a more realistic approach was not taken towards costing.

According to the NRA the toll revenue from small vehicles is minimal but 'roughly offsets maintenance costs'. Therefore for simplicity it will be assumed that this will always be the case and both their toll revenues and maintenance costs will be removed from the streams of discounted costs and benefits throughout the appraisal period (30 years).[3] The cost outlay of €752m for the project is converted from 2006 prices to 2002 prices to €662.454m in order to compare the values of the costs and benefits.

	Time (€m)	Accident (€m)	Fuel (€m)	Total Benefit (€m)	Costs (€m)
2006	-	-	-	-	662.454
2007	22.545	12.305	5.009	39.859	-
2008	21.678	11.831	4.816	38.326	-
2009	20.844	11.376	4.631	36.852	-
2010	20.042	10.939	4.453	35.435	-
2011	19.272	10.518	4.282	34.072	-
2012	18.530	10.113	4.117	32.761	-
2013	17.818	9.725	3.959	31.501	-
2014	17.132	9.350	3.806	30.290	-
2015	16.473	8.991	3.660	29.125	-
2016	15.840	8.645	3.519	28.004	-
2017	15.231	8.313	3.384	26.927	-
2018	14.645	7.993	3.254	25.892	-
2019	14.082	7.686	3.129	24.896	-
2020	13.540	7.390	3.008	23.938	-
2021	13.019	7.106	2.893	23.018	-
2022	12.518	6.832	2.781	22.132	-
2023	12.037	6.570	2.674	21.281	-
2024	11.574	6.317	2.571	20.463	-
2025	11.129	6.074	2.473	19.676	-
2026	10.701	5.840	2.377	18.919	-
2027	10.289	5.616	2.286	18.191	-
2028	9.894	5.400	2.198	17.491	-
2029	9.513	5.192	2.114	16.819	-
2030	9.147	4.992	2.032	16.172	-
2031	8.795	4.800	1.954	15.550	-
2032	8.457	4.616	1.879	14.952	-
2033	8.132	4.438	1.807	14.377	-
2034	7.819	4.267	1.737	13.824	-
2035	7.518	4.103	1.670	13.292	-
2036	7.229	3.945	1.606	12.781	-

[3] Source: 'Project Appraisal Guidelines', Appendix 6 'National Parameters Value Sheet', NRA, 2008:4

Total	716.816	662.454

Table 3: Stream of costs and benefits (at the 4% discount rate): 2002 prices in euro.
Note: the project was completed in December 2006 so it is assumed that no benefits will occur in that year.

Summary of CBA Cash Flows

Using a 4% discount rate the values of benefits (cash inflows) can be seen over time; this analysis shows that these only marginally cover the costs. The internal rate of return (IRR) is therefore determined to be 4.33%, only slightly higher than the 'hurdle rate' on public sector projects of 4% (NRA, 2008). It is important to note however, that the above calculations are based on zero growth rates in traffic and income levels (it can be viewed as a pessimistic scenario), and since this may be unrealistic over a 30 year period, sensitivity tests showing growth in these areas would result in higher IRRs. Time savings account for 57% of the benefits of the DPT, so the IRR would be most sensitive to changes in the monetary values attached to these (Barrett and Mooney, 1984), which also vary according to sensitivity tests. Nevertheless, the above analysis shows an observed Benefit/Cost ratio of merely 1.082:1, which is considerably less than the pre-construction appraisal summary figures that show a ratio of 4.56:1.[4] The EIS also applies a NPV of €789.21m to the project (whereas this analysis has found an NPV of €54.4m, very small in comparison to overall cost) with an IRR of 15.4% - significantly greater than the above findings.

Unquantifiable Benefits

These take the form of 'amenity and environmental aspects of road investment' (Barrett and Mooney, 1984: 30), but despite difficulty in valuation, these items are 'none the less important' (ibid.: 31). A significant result of the tunnel project is the resulting HGV ban, and this has had a tangible impact due to the removal of environmentally deficient vehicles from the city. The DCC (1998c) states that this gives rise to an automatic increase in the quality of the environment that is immediately noticeable since there is a reduction in noise and pollution levels in central areas. However, it is argued anecdotally that due to air currents particular to Dublin's coastal location, the increase in air quality is not significant since it was reasonable to begin with – this indeed is difficult to quantify.

Conclusion

Significantly, the differences between the 1998 EIS appraisal summary figures and the findings in this paper are due mostly to an initial understatement of costs as opposed to an overstatement of benefits. Even if the costs had remained at the level of the tender price (€457m – still significantly higher than the EIS forecast) there would have been a more favourable Benefit-Cost ratio of 1.57:1, an NPV of €259.8m and an IRR of 7.81 per cent. This must then call into question the validity of the initial appraisal, and lay blame on the part of the contractee of the project for the significant overrun. Nevertheless, this analysis allows the DPT to pass three 'decision rule' criteria for an

[4] Figures were adapted to consider a 4% discount rate as opposed to a rate of 5% that is used in the EIS (1998).

individual project: NPV > 0; Benefit-Cost ratio > 1:1; and the IRR > the NRA 'hurdle' discount rate. However, the discounted benefits shown by these methods as part of the CBA only marginally exceed the costs, delivering only a small gain to the welfare of society. While there may be drawbacks in terms of the breadth of this type of analysis, it is apparent why it is considered 'the most important technique for project appraisal in the public sector' (Mulreany, 2002: 1). Perhaps the most disappointing result in this study is the apparent lack of accountability for public investment projects and this highlights the fear that 'the failure to publish *ex post* cost benefit analyses of these projects increases the taxpayer risk in further tunnel… transport projects' (Barrett, 2006: 41).

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