



**CBA Builder Simple and Advanced**

**Instruction Manual**

**v1.2**



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# 1 Introduction

CBA Builder is a Microsoft Excel based cost benefit analysis tool designed for use in teaching and learning, and also in real applications of CBA. This manual provides users with instructions and guidance for using both versions of CBA Builder, CBA Builder Simple and CBA Builder Advanced. The manual provides users with detailed descriptions of how to make the most of the various functions contained within both CBA Builder Simple, and CBA Builder Advanced. The manual also includes relevant examples which users can work through in order to develop an understanding of the various ways in which the CBA Builder can be used.

The manual is divided as follows: section 2 covers CBA Builder Simple; section 3 covers CBA Builder Advanced; the manual also contains frequently asked questions in section 4. Section 4 provides a quick reference for a number of potential questions users may have. This section was informed by the trialling and testing process undertaken during the development of the CBA Builder.

## Results

**Net Present Value (NPV)**

$NPV = PV(B) - PV(C)$

**NPV = £575.71**

**Net Present Value (NPV) with Horizon Value**

$NPV = PV(B) - PV(C) + PV(H)$

**NPV = £5,951.20**

**Benefit Cost Ratio (BCR)**

$BCR = PV(B) / PV(C)$

**BCR = 1.14**

### Discount Rate Sensitivity Analysis

Social Discount Rate:   
 Discounted Horizon Value (£):

Discount Rate (-)	NPV	NPV + H
10	£62,430.73	£521,478.71
9	£55,334.52	£422,038.04
8	£48,621.27	£342,253.88
7	£42,266.38	£277,936.28
6	£36,247.12	£225,827.59
5	£30,542.42	£183,387.83
4	£25,132.75	£148,631.03
3	£20,000.00	£120,000.00
2	£15,127.35	£96,270.37
1	£10,499.17	£76,476.75
0	£6,100.92	£59,855.84
Discount Rate (+)		
1	£1,919.07	£45,802.43
2	£-2,058.98	£33,835.26
3	£-5,844.97	£23,570.57
4	£-9,449.88	£14,701.43
5	£-12,883.91	£6,981.66
6	£-16,156.84	£213.16
7	£-19,277.00	£-5,763.94
8	£-22,253.34	£-11,079.11
9	£-25,093.49	£-15,837.53
10	£-27,804.77	£-20,124.93

**Breakeven Discount Rate (NPV = 0): 4.5**

**Breakeven Discount rate with Horizon Value (NPV + H = 0): 9.1**

### Valuing the Environment

**Travel Cost Method**

Type of Asset:   
 Wage Rate (£/h):

Zone	Time to Asset (hr)	Distance to Asset (km)	Admission Fee (£)	Total Cost (£)	Average Total Visits (per year)
Zone 1	1	10	10	21.6	100
Zone 2	1.5	15	10	27.4	120
Zone 3	2	20	10	33.2	50
Zone 4	4	30	10	54.8	10

**Value of Environmental Asset: £7,656.00**

**Preventative Expenditure**

Preventative Measures	Cost (£)

**Value of Environmental Asset: £0.00**



The discounted cost of the site purchase is therefore the same as the nominal cost. In contrast, the replace windows cost occurs in year 10, after the project has been in place for a number of years. The discounted value of the cost of replacing windows (£10,000) is equal to £7,440.94 at a discount rate of 3%. The discounting equation used to produce this discounted cost is show below (1).

$$P = \frac{F}{(1 + r)^n} \tag{1}$$

In this equation P is equal to the present value of the cost or benefit, F is equal to the future value, r is equal to the rate of discount (entered as a decimal e.g. 3% would be entered at 0.03), and n is equal to the year in which the cost or benefit occurs.

*Multiple Year Costs*

Users can enter up to 10 separate multiple year costs. Each of these multiple year costs can occur from year 0, or the beginning of the analysis period, until year 20. Twenty years was chosen as the limit for the CBA period on CBA Builder Simple as it is a commonly used period length in CBAs, for example in road development projects (see Boardman et al, 2006, 142).

When entering costs that occur on multiple years users are presented with a number of additional options. Figure 2 shows a portion of the Multiple Years Costs table. Maintenance costs for a CBA project have been entered into years 1, 2 and 3. The maintenance cost is £10,000 per annum.

Enter Costs Occurring on Multiple Years						
Name of Cost		0	1	2	3	4
	Monetary Value (£)		£10,000.00	£10,000.00	£10,000.00	
	Growth Rate					
	Lag Factor					
	Compound Value (£)	£0.00	£10,000.00	£10,000.00	£10,000.00	£0.00
	Discount Rate		3.00	3.00	3.00	
Maintenance	PV (C)	£0.00	£9,708.74	£9,425.96	£9,151.42	£0.00
	Monetary Value (£)					
	Growth Rate					
	Lag Factor					

Figure 2: Multiple Year Costs

The present values of these future costs are discounted using the discount rate (%) entered by the user. Notice that over time the present value of the future cost (£10,000) decreases. This represents the effect of the decreasing value of money over time, due to inflation and other such factors. These values are calculated using the discounting multiple years equation shown below (2).

$$P = \frac{F}{(1 + r)^0} + \frac{F}{(1 + r)^1} + \dots + \frac{F}{(1 + r)^n} \tag{2}$$

In addition to being able to discount future costs to present values, users can also account for growth or inflation of certain costs in their CBA using CBA Builder Simple. This feature has been included to allow the user greater flexibility when determining the future and present value of both costs and benefits involved in a project. Users can enter a growth or inflation rate. This is particularly useful when considering costs such as maintenance or wages which will of course increase over time as inflation increases the wage rate for example. Figure 2 shows a worked example of this nature. In Figure 2 we can see that the total cost of wages for workers at a planned training and enterprise centre (see CBA Builder Simple Worksheet 1) are estimated at £126,000 per annum beginning in year 2, once construction of the centre is complete and the centre has been launched. However, wages are estimated to grow at a range of 1.5% per annum, so this needs to be factored into the cost of wages for the centre as shown in Figure 3.

Enter Costs Occurring on Multiple Years						
Name of Cost		0	1	2	3	4
Wages: ETC Staff	Monetary Value (£)			£126,000.00	£126,000.00	£126,000.00
	Growth Rate			1.50	1.50	1.50
	Lag Factor			2	2	2
	Compound Value (£)	£0.00	£0.00	£126,000.00	£127,890.00	£129,808.35
	Discount Rate			3.00	3.00	3.00
	PV (C)	£0.00	£0.00	£118,767.08	£117,037.47	£115,333.04
	Monetary Value (£)					
	Growth Rate					
	Lag Factor					
	Compound Value (£)	£0.00	£0.00	£0.00	£0.00	£0.00

Figure 3: Applying Growth to Costs

The nominal wage cost is £126,000. This is the cost of staffing the centre in the first year the centre is open (year 2 of the CBA period). The growth rate (1.5%) is entered underneath the value of the cost. Underneath this a lag factor has been added to represent the fact that the wages cost is not experienced until year 2, and it is known that in year 2 wages will cost £126,000. A lag factor of 2 has been entered. This adjusts the calculation made by the template to acknowledge that the cost does not occur until year 2. Similarly if you wished to lag a cost which first occurs in year 4, you would enter 4 into the lag factor field in year 4 when entering this cost.

Notice that entering a growth value has changed the compound value of the costs of wages in years 3 and 4, from £126,000 to £127,890 and £129,808.35 respectively. These values can then be discounted to account for the decreasing value of money during the period by entering a discount rate, in this example 3%, into the discount rate field for each year.

*Net Present Value of Costs*

The overall net present value of the costs entered into both the one-off costs and multiple year costs tables is shown at the bottom of the costs tab, as shown in Figure 4. This value automatically updates with entry of additional costs or removal of costs and provides the user with a running total for the costs involved in a project.

	Compound Value (£)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	Discount Rate						
	PV (C)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	Monetary Value (£)						
	Growth Rate						
	Lag Factor						
	Compound Value (£)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	Discount Rate						
	PV (C)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	Monetary Value (£)						
	Growth Rate						
	Lag Factor						
	Compound Value (£)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
	Discount Rate						
	PV (C)	£0.00	£0.00	£0.00	£0.00	£0.00	£0.00
<b>Total Net Present Value of Costs</b>							<b>£483,578.53</b>

Figure 4: NPV of Costs

### 2.2.2 Benefits

Entering benefits follows the same format as the entry of costs described in section 2.2.1. The benefits tab is presented in the same way as the costs tab. Users can enter one-off benefits, benefits occurring on multiple years, and can account for the effect of growth/inflation on certain benefits, as well as discounting future values to present values.

### 2.2.3 Horizon Value

A feature of the CBA Builder Simple is the ability to calculate a horizon value as part of a CBA. A horizon value is a long term estimate of the net benefits associated with project, beyond the initial period of the CBA analysis, which is usually twenty years. In CBA Builder Simple users can calculate a horizon value using one of four available methods. Users can calculate a horizon value using all four methods if they choose, and if this is appropriate given the nature of the project they are appraising, perhaps to compare the different valuations. However, users should note that only one final horizon value can be used to inform the overall results of the CBA (and the sensitivity analysis). Users should therefore choose their preferred method and only include this horizon value in their final CBA.

#### *Simple Projection*

Using the simple projection method users can produce a long term horizon value for a CBA project by simply entering the estimated annual net benefit of the project from the beginning of the horizon period, the social discount rate, and a growth or decline rate for the value of the net benefit. An example is shown in Figure 5. The future value of the net annual benefits associated with a project is estimated at £1,000.00. This net benefit is estimated to grow at a rate of 1% per annum, which has been entered into the growth/decline rate field. Finally a social discount rate of 3% has been entered at the top of the horizon value page. This produces a horizon value of £26,877.46 as shown in Figure 5. This is the estimate for the long term net benefits associated with the CBA.

Users should note that the growth rate must be less than the value given for the social discount rate when using the simple projection method (see Boardman et al (2006, 143-159) for more on this).

<b>Estimating a Horizon Value</b>		<b>CBA Simple BUILDER</b>
Beginning of Horizon Period (Year)	<u>20</u>	
Social Discount Rate	<u>3</u>	
<b>Method</b>		
<b>Simple Projection</b>		
Future Value for Net Benefits (£)	<u>£1,000.00</u>	
Growth/Decline Rate (%)	<u>1</u>	
<b>Horizon Value</b>	<b>£26,877.46</b>	

Figure 5: Simple Projection Horizon Value

### Scrap Value

An alternative method of calculating a horizon value is using a scrap or liquidation value. This simply discounts to present value the estimated future scrap or liquidation value of an asset, for example a large piece of machinery, or a building. This method is therefore appropriate to use when there is a clear end to a project, after twenty years for example, and an asset or set of assets that will be scrapped at this point.

Using CBA Builder users can simply enter the estimated future scrap value of the asset, as well as the social discount rate and beginning of the horizon period (or end of the project) at the top of the horizon value tab. The scrap value is then discounted using this information to provide a horizon value using the scrap or liquidation method.

### Depreciated Value

The depreciated value method of calculating a horizon value involves depreciating the initial value of an asset or project (a training centre for example), to determine its long term value after a given period of time. This method is again suitable when there is a more clearly defined end to a project. It enables the user to calculate the future value of an asset, given the impact of depreciation, or reductions in the value of that asset over time.

To calculate the depreciated value of an asset using CBA Builder, users begin by entering the initial value of the asset, as shown in the example in Figure 6. A depreciation rate then needs to be entered. This could be estimated by looking at the depreciation rates of similar assets. Finally the period of the depreciation should be entered, twenty years in the example shown in Figure 6, to show the length of the project. In the example, this gives a depreciated value of £67,297.13 for the asset after twenty years.

<b>Depreciated Value</b>	
Initial Value of Asset (£)	<u>£100,000.00</u>
Depreciation Rate (%)	<u>2</u>
Depreciation Period (Years)	<u>20</u>
<b>Horizon Value</b>	<b>£67,297.13</b>

Figure 6: Depreciation Method Horizon Value



### Initial Construction Cost

The final method of calculating a horizon value is using the initial construction cost method. This method calculates a horizon value using the initial cost of construction of an asset or project, but subject to a reduction factor. The reduction factor is a percentage (%) representing the remaining proportion of the initial construction cost which the asset or project is worth in the long term, or at the end of the project.

Figure 7 shows a worked example using the initial construction cost method. Users enter the initial construction cost, in this example £1.5m. Then users enter the reduction factor, in this case 80%. This value is used to show that the long term future value of the asset is estimated as being equal to 80% of the initial construction cost. Users also need to make sure they have entered a social discount rate (£5 in this example), and a year for the beginning of the horizon period (year 20 in this example), so that the future value of the initial construction cost can be discounted to present value. This gives a discounted horizon value of £645,059.13 in the example shown in Figure 7.

<b>Initial Construction Cost</b>	
Initial Construction Cost (£)	£1,500,000.00
Reduction Factor (%)	80
<b>Horizon Value</b>	<b>£645,059.13</b>

Figure 7: Initial Construction Cost Horizon Value

### 2.2.4 Results

Results in CBA Builder are calculated automatically for the user. However, it is important that the user understands how the results are calculated and how to interpret the results. Results are given in three forms (1) net present value (NPV), net present value with a horizon value (NPV + H), and using the benefit cost ratio (BCR). An example of a completed results tab is shown in Figure 8.

#### Net Present Value (NPV)

The Net Present Value of the CBA is equal to the sum of the discounted benefits associated with the project minus the sum of the discounted costs. The equation for calculating NPV is given below (3).

$$NPV = PV(B) - PV(C) \quad (3)$$

In the example shown in Figure 8 the NPV calculated using CBA Builder is equal to £575.71. This is calculated by taking the sum of the net present value of the benefits, in this example £4,575.71, and subtracting the sum of the net present value of the costs, in this case £5,000.

If the NPV of the CBA is greater than zero ( $NPV > 0$ ) then there is economic justification for the project to go ahead. If NPV is less than zero then the project should not go ahead ( $NPV < 0$ ). A zero value for NPV is equal to the breakeven rate, and means that the benefits and costs of the project are equal. In this case determining whether the project should go ahead is less clear.

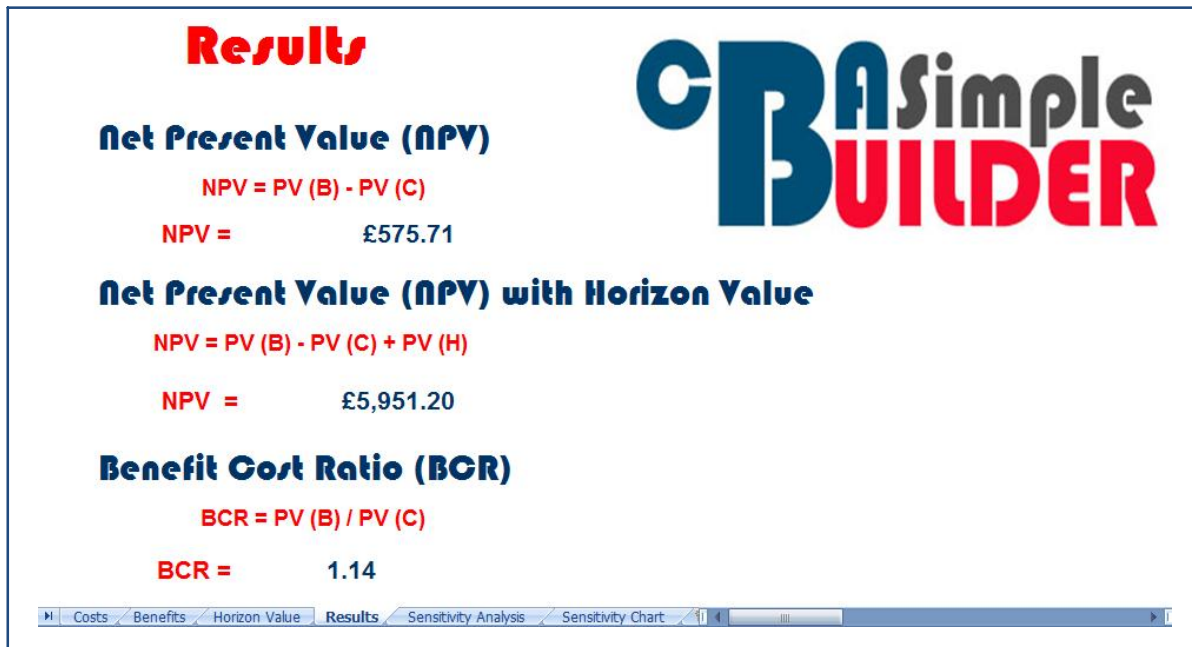


Figure 8: Results

#### *Net Present Value with a Horizon Value (NPV + H)*

The CBA Builder also calculates the net present value for the CBA with the horizon value included. This gives not only a value for the net present value of the project during the short term period (usually twenty years), but also includes a net benefit valuation for the long term. This is calculated using the equation below (4).

$$NPV = PV(B) - (PV(C) + PV(H)) \quad (4)$$

In the example in Figure 8, the NPV with horizon value is £5,951.20. This is calculated by adding the horizon value of £5,375.49, to the NPV of £575.71. The inclusion of a horizon value can in some projects make a significant difference in the overall outcomes. For example, in the example given in Figure 8, if the NPV had been -£575.71, the NPV of the project would be less than zero, and

therefore the CBA would suggest that the project should not go ahead. However, adding the horizon value of £4,799.78. This is a positive value and suggests that the project should go ahead. In this case the inclusion of the horizon value would potentially be the determining factor in whether the project goes ahead.

#### *Benefit Cost Ratio (BCR)*

The final result calculated by CBA Builder is the benefit cost ratio. This is calculated using the equation below (5). Using this method of obtaining a result for the CBA, a value of one or more ( $BCR \geq 1$ ) gives economic justification for a project to go ahead, while a BCR of less than one ( $BCR < 1$ ) suggests the project should not go ahead. In the example given in Figure 8, the BCR is equal to 1.14 providing economic justification for the project to go ahead.

$$NPV = \frac{PV(B)}{PV(C)} \quad (5)$$

#### **2.2.5 Discount Rate (DR) Sensitivity Analysis**

The sensitivity analysis allows the user to analyse the impact of different social discount rates on the costs and benefits that occur during the period of the CBA (usually twenty years), as well as the impact different social discount rates have on the horizon value.

The sensitivity analysis provides a breakeven value which gives the user the social discount rate at which the CBA Net Present Value (NPV) is equal to zero. This tells the user the social discount rate at which the project costs are equal to the project benefits. This will be different (in most cases) for project NPV compared with NPV + H. The sensitivity analysis tab shows the user the values for NPV and NPV + H for a range of different social discount rates, +/- 10% of the social discount rate used in the analysis. The user must enter the social discount rate used in the CBA at the top of the tab in the social discount rate field. Note that in the current version (v1.1) of CBA Builder, the maximum discount rate a user can input is 10% if they wish to use the sensitivity analysis tool.

Notice also that the discounted horizon value is provided on the tab. The sensitivity analysis table shown in Figure 9 shows that for this example CBA the NPV at a social discount rate of 3% (with zero change in the table) is £6,100.92. With the horizon value included, the NPV at 3% social discount rate is £53,754.93. With a 2% addition in the social discount rate (a social discount rate of 5%) the NPV of the project becomes negative (£2,058.98). This indicates to the user that only a relatively small change in social discount rate renders the project no longer economically justifiable. This is an important result as it suggests to the user that the net benefits of this project are more uncertain.

Breakeven discount rates are also provided for the user. These gives the social discount rate (%) at which the sum of the costs is equal to the sum of the benefits, thus giving an NPV of zero. Any discount rate above that given in the breakeven discount rate field would result in a negative NPV. This value can then be used along with the social discount rate used to give the sensitivity level for the CBA. In the example shown in Figure 9, the social discount rate is 3% and the breakeven rate is

4.5% (without a horizon value). The sensitivity level is therefore 1.5%, as an increase of more than this would result in a negative NPV.

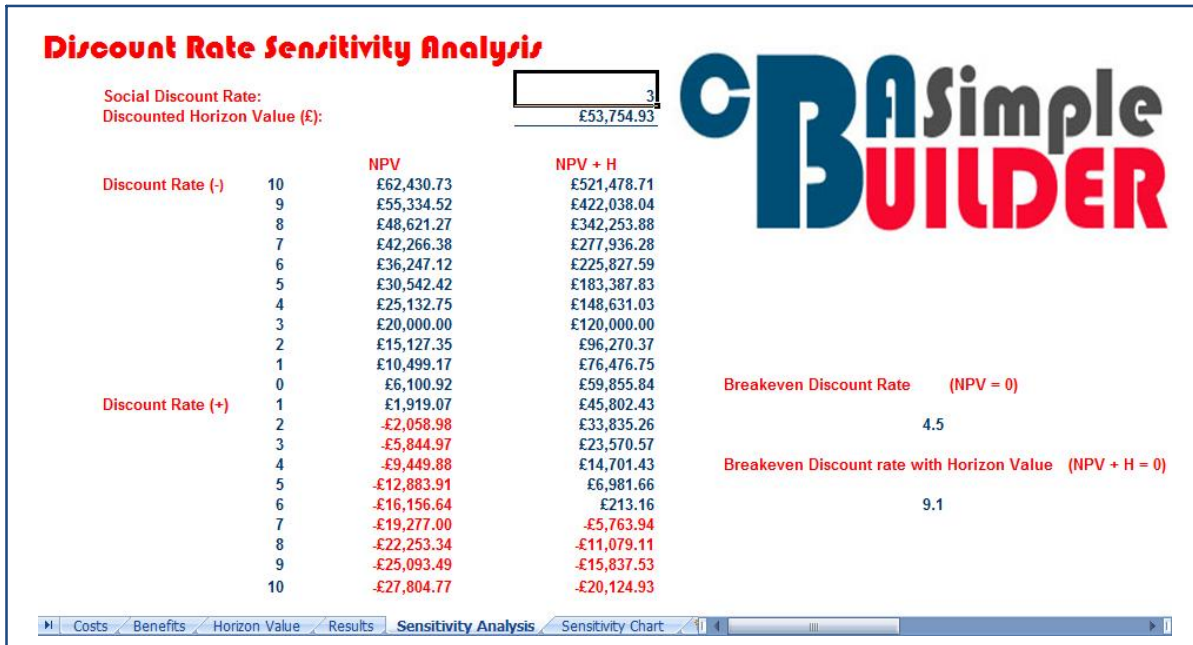


Figure 9: Sensitivity Analysis

In addition to the sensitivity analysis, a discount rate sensitivity chart is produced automatically by CBA Builder on the sensitivity chart tab. This shows, graphically, the various net present values, and NPVs including a horizon value, for the CBA subject to different social discount rates. Figure 10 provides an example sensitivity chart. This is the chart produced using the data in Figure 9. The chart is a useful illustrative tool for showing the discount rate at which the CBA reaches breakeven point and thus the rate above which the project is no longer economically justifiable. Care should be made not to interpret the negative values on this chart, as they refer to negative social discount rates (i.e. the social discount rate entered minus a rate greater than the one used).

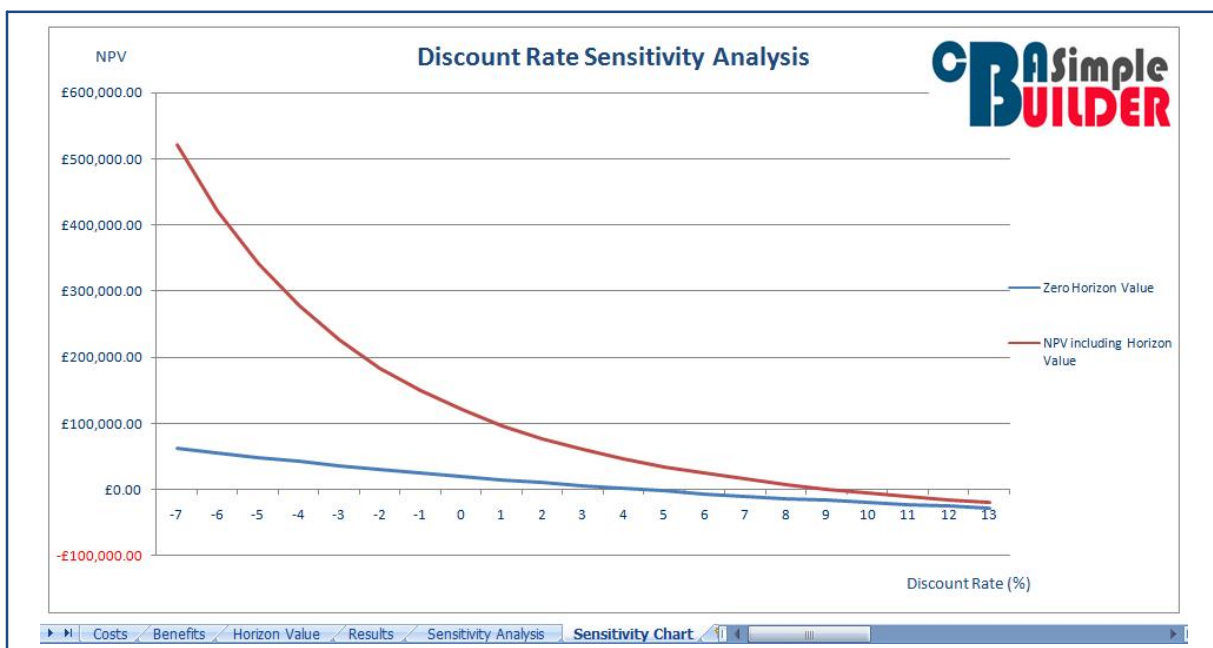


Figure 10: Sensitivity Analysis Chart

## 3 Advanced CBA Builder

### 3.1 Getting to know CBA Builder Advanced

CBA Builder Advanced contains all of the same features as CBA builder Simple, but in addition provides the user with added functionality to produce detailed estimates for a number of specific variables found in many CBAs. These include calculating the net benefits from time-savings, determining valuations for the environment, and calculating values for the net benefits associated with life savings and accident reduction.

### 3.2 Constructing an Advanced CBA

Constructing a CBA using CBA Builder Advanced involves many of the same processes as with CBA Builder Simple. Entering one-off costs and benefits, and multiple year costs and benefits is performed in the same way as described in section 2.2.1 of this manual. Similarly calculating a horizon value is performed in exactly the same way as described in section 2.2.2. Each of the additional elements of functionality, however, have their own separate tabs, and this section of the manual will focus on how to use this added functionality, in order to get the most out of creating a CBA using CBA Builder Advanced.

#### 3.2.1 Time-Savings

CBA Builder Advanced allows users to estimate the net benefits which arise from time-savings for a given project. This is particularly useful in CBAs which deal with road building or road extensions, or projects which seek to improve public transport provision for example. Using CBA Builder Advanced users can choose between two methods of time-savings calculations exist, the simple wage rate method, and the COBA method.

##### *Simple Wage Rate Method*

The simple wage rate method of estimating time-savings calculates a value for time-savings based on the average hourly wage rate, and the total estimated hours saved per year. Users can calculate this value of time-savings using this method for each year from year 0 until year 20 as with the costs and benefits tabs. The total value of time-savings calculated using this method is then given. An example of the simple wage rate method is shown in Figure 11.

Wage rates can be entered into the wage rate fields. CBA Builder Advanced then calculates the annual value of this wage rate, and multiplies this by the number of hours entered into hours saved field. The hours saved value should be an estimate of the total number of hours saved as a result of the CBA project in each year. In the example in Figure 11, wage rates of £8, £8.50, £9, and £9.50 have been entered for years 1, 2, 3 and 4. The number of hours saved in each year has also been estimated. For example, 800 hours are estimated to be saved in year 3. The CBA Builder then calculates the time-savings for each year e.g. £7,200 in year 3, and also the total time-savings of £29,025.00 in this example.

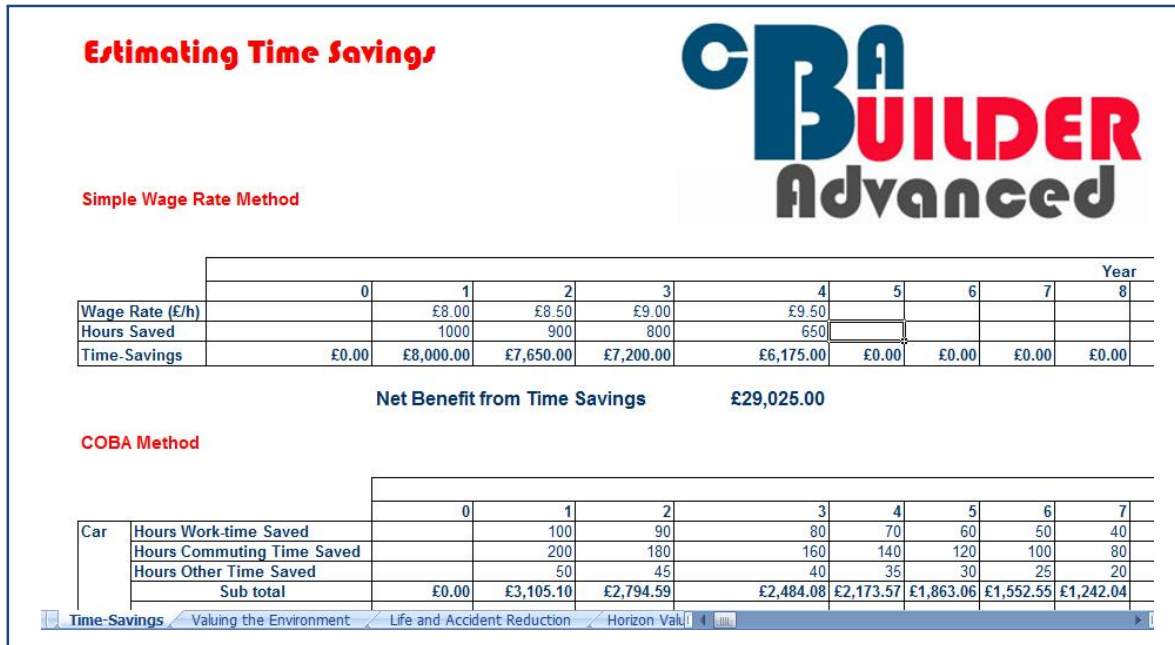


Figure 11: Time-Savings Wage Rate Method

*COBA Method*

An alternative and arguably more detailed method is the COBA method. This is based on the UK Department for Transport’s method of calculating time-savings associated with new trunk road developments (see DfT, 2009). The COBA method involves separating out the time-savings for different types of vehicles using roads. In CBA Builder this is split into Cars, LGVs (Light Goods Vehicles), OGVs (Other Goods Vehicles), and Personal Service Vehicles (PSVs) as per the categorisations used in the DfT’s COBA.

Users can enter the number of hours saved for years 0 to 20 as per the simple wage rate method of calculating time-savings. When entering the number of hours saved, hours are broken up into work-time, commuting time and other time (although not all vehicle types have all of these options). Users can therefore enter the total number of hours saved per year for car drivers in relation to work-time, time spent commuting, and other time (including leisure activities). An example of a completed time –savings valuation is shown in Figure 12.

In this example, various hour savings have been entered for cars, LGVs, OGVs, and PSVs for years 1 to 7. By simply entering the relevant number of hours users get a valuation for the time-savings associated with each type of vehicle (shown in the sub total fields). These are added for each vehicle type and for each year to give a value for the total net benefit from time-savings using the COBA method.

**COBA Method**

		0	1	2	3	4	5	6	7
Car	Hours Work-time Saved		100	90	80	70	60	50	40
	Hours Commuting Time Saved		200	180	160	140	120	100	80
	Hours Other Time Saved		50	45	40	35	30	25	20
	Sub total	£0.00	£3,105.10	£2,794.59	£2,484.08	£2,173.57	£1,863.06	£1,552.55	£1,242.04
LGVs	Hours Work-time Saved		500	450	400	350	300	250	200
	Hours Commuting Time Saved		50	45	40	40	35	30	25
	Hours Other Time Saved		50	45	40	35	30	30	25
	Sub total	£0.00	£4,602.50	£4,142.25	£3,682.00	£3,242.60	£2,782.35	£2,340.50	£1,880.25
OGVs	Hours Work-time Saved		100	90	80	70	60	50	40
	Sub total	£0.00	£842.00	£757.80	£673.60	£589.40	£505.20	£421.00	£336.80
PSVs	Hours Work-time Saved		100	90	80	70	60	50	40
	Sub total	£0.00	£448.49	£403.64	£358.79	£313.95	£269.10	£224.25	£179.40
Total Annual Time Savings		£0.00	£8,998.09	£8,098.28	£7,198.47	£6,319.52	£5,419.71	£4,538.30	£3,638.49
<b>Net Benefit from Time Savings</b>					<b>£44,210.86</b>				

Time-Savings Valuing the Environment Life and Accident Reduction Horizon Val

Figure 12: Time-Savings COBA Method

Users can calculate estimates using both methods to compare the valuations given. However, only one method should be used in the final CBA as the total benefit from time savings used in calculating the results, and in the sensitivity analysis requires the calculation of only one method of time-savings.

### 3.2.2 Valuing the Environment and Education

Another element of the added functionality provided in CBA Builder Advanced is the ability to provide valuations for environmental assets, as well as valuations for education using a simple method. This can be done using various different methods dependent on the exact nature of the asset in question. Five methods are available to users in CBA Builder Advanced. These are the (1) travel cost method; (2) preventative expenditure method; (3) asset valuation method; (4) replacement cost method, and; (5) the intermediate good method.

#### *Travel Cost Method (TCM)*

The travel cost method (TCM) of valuing an environmental asset base its valuation in the relative use and cost of access to an environmental asset. The method exact nature of the method include in CBA Builder Advanced is the zonal travel cost method. This allows users to calculate the value of an environmental asset in relation to the number of visits it received from individuals in up to four different zones, determined by the time taken to get to the environmental asset, and distance to the asset. An example of a completed valuation of an environmental asset is shown in Figure 13.



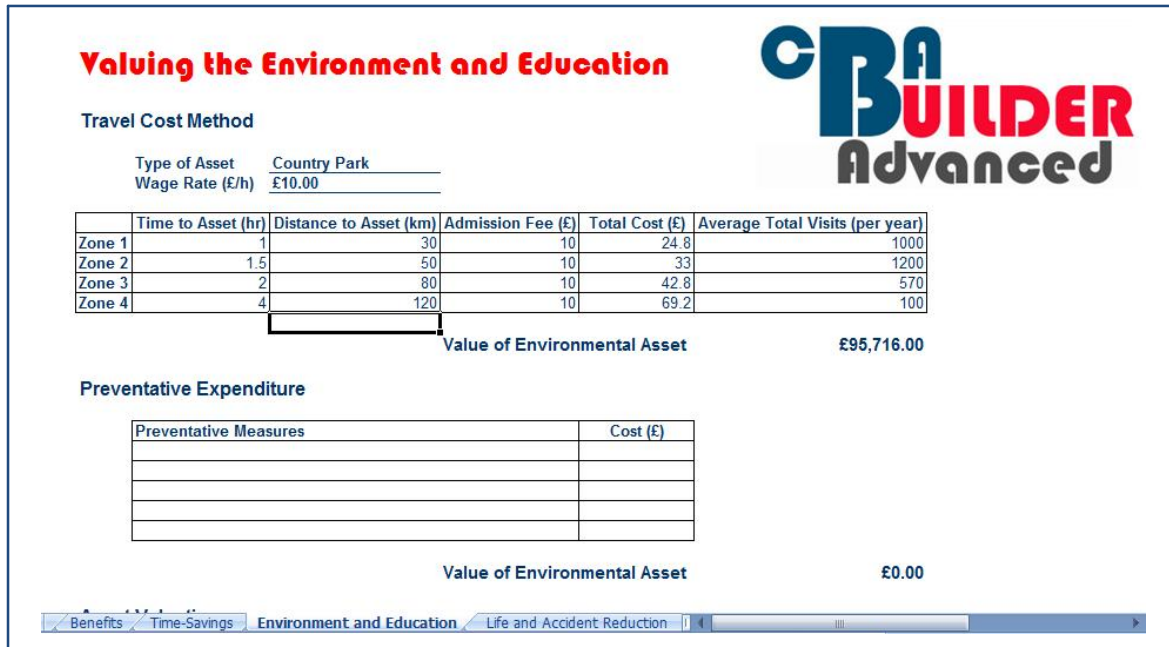


Figure 13: Simple Travel Cost Method

In this example the type of asset has been entered as a country park. Users should also enter a value for the average hourly wage rate (£) at the top of the valuing the environment tab. Users can obtain a value for the net benefit of preserving this environmental asset. For each zone users enter the average time taken to reach the environmental asset (in hours), the distance to the environmental asset (in km), the admission fee, and the cost of admission (if there is one). In the example shown in Figure 13, for zone 1, the time to asset has been entered as one hour, the distance as 30km, an admission fee as £10, and the average total visits per year as 1000. The table has been similarly filled out for the other three zones. This provides a total valuation of this environmental asset as £95,716.00. This asset therefore provides a net benefit of 95,716.00.

*Note:* If users wish to include the value of an asset as a cost i.e. if users wish to include that environmental asset in relation to its loss, the analysis can be calculated in exactly the same way, but by simply inputting negative values for the number of visits, or lost visits in this case. This then provides a negative overall value to input into the CBA as a negative net benefit (or cost) resulting from the loss of an environmental asset. This is shown in Figure 14 below using the same values entered into the previous example in Figure 13, but with negative figures for the number of visits. This gives a negative overall valuation for the asset, which can be used in the CBA to represent the cost associated with the loss of this country park, as a result of pollution, or development for example.

## Valuing the Environment and Education

**Travel Cost Method**

Type of Asset Country Park  
Wage Rate (£/h) £10.00


	Time to Asset (hr)	Distance to Asset (km)	Admission Fee (£)	Total Cost (£)	Average Total Visits (per year)
Zone 1	1	30	10	24.8	-1000
Zone 2	1.5	50	10	33	-1200
Zone 3	2	80	10	42.8	-570
Zone 4	4	120	10	69.2	-100

**Value of Environmental Asset** **-£95,716.00**

**Preventative Expenditure**

Preventative Measures	Cost (£)

**Value of Environmental Asset** **£0.00**



Benefits Time-Savings **Environment and Education** Life and Accident Reduction

Figure 14: Using the Travel Cost Method as a net Cost

### *Preventative Expenditure*

The preventative expenditure method of calculating the value of an environmental asset uses a simple total value of all the funds spent on preventative measures used to ensure the continued existence of the environmental asset. Users can enter the name of each preventative measure, up to a total of five, and the cost of each. The valuation of the asset is simply the sum of these costs. The more money which has been spent on preserving the asset, the more the valuation of the environmental asset will be.

### Asset Valuation

The asset valuation method compares the average value of an asset which has certain desirable qualities, against the average value of an asset which does not. Using CBA Builder Advanced users simply enter the average valuation in £s for both the asset with and without the certain desirable features, and this provides an estimate of the value of the asset. For example, in a town houses near a park have an average value of £250,000, but houses which are not near the park have a value of £190,000. The value of the park (the asset) can therefore be estimated at £60,000 for each house. Users then enter the number affected by this desirable attribute (e.g. 10), to give a value for the environmental asset, in this example £600,000.

*Note:* The asset valuation method can also be used for assets with undesirable attributes by simply entering the value of an asset with undesirable attributes e.g. the value of a house which suffers from pollution from a road into the average value w/ desirable/undesirable environmental attributes field. As this house would likely have a lower average value than one without the undesirable attribute, the result will be a negative value for this environmental impact (or a net cost) and can be

used in the CBA in the same way as described in the travel cost method section. Using the asset valuation method in this way is shown in Figure 15.

Asset Valuation	
Average value w/ desirable/undesirable environmental attributes	£80,000.00
Average value without these attributes	£190,000.00
Number affected by desirable/undesirable attribute	10
<b>Value of Environmental Asset</b>	<b>-£1,100,000.00</b>
Replacement Cost	
Total Cost avoided through Abatement	£0.00
<b>Value of Environmental Asset</b>	<b>£0.00</b>
Intermediate Good Method	
Intermediate Good	
Costs	Benefits
Time-Savings	Valuing the Environment
Life and Accident Reducti	

Figure 15: Using the Asset Valuation Method for Undesirable Attributes

### *Replacement Cost*

The replacement cost method of valuing an environmental asset simply requires the user to input a valuation for the cost of replacing this asset. This valuation may be made from looking at similar assets and comparing the relative values given to them, or the prices paid to ensure their continued existence. This cost is then the cost that is avoided by ensuring the asset continues to exist.

*Note:* Again users can enter a negative value for the replacement cost method. This can be used as a value for an environmental asset which will be lost as a result of a project.

### *Intermediate Good Method*

The intermediate good method seeks to provide a valuation for an asset based on the relative value of the asset in two different states. For example, the intermediate good method could be used to estimate the value of an environmental asset such as a park with a recreational area for children and one without, by looking at the relative income of businesses immediately surrounding the park compared to those which do not surround the park. This obviously raises the question of providing values for these assets. However, once these values are obtained, or estimates for them, they can be entered into the 'value of good in state A, and 'value of good in state B' fields respectively. The number of number of businesses with the good in state A (or the number of businesses near the park in our example) should then be entered in the number in state A field. This will then provide a valuation for the asset using the intermediate good method.

*Note:* This method is often used to calculate the relative value and therefore benefit of education, as the user can compare the average income of individuals with a certain level of qualifications against that don't have them. This operation can be performed in CBA Builder Advanced by entering the average income level of individuals with a certain qualification into the 'value of good in state A' field, and the average income of those without the qualification into the 'value of good in state B' field. For example, in Figure 16 it is estimated that the average earnings for an individual with a training qualification which will be offered at an enterprise training centre (ETC) is £22,000, compared with an average income of £15,000 for those without the qualification. It is estimated that twenty individual will benefit from gaining this qualification in the CBA period. This provides a valuation for this asset (the qualification) of £140,000.

Intermediate Good Method	
Intermediate Good	
Value of Good in State A	<u>Training Qualification</u>
Value of Good in State B	£22,000.00
Number in State A	£15,000.00
	20
	<b>Value of Asset</b>
	<b>£140,000.00</b>
	<b>Net Benefits from Asset</b>
	<b>£140,000.00</b>

Figure 16: Intermediate Good Method

Users can calculate a number of values for an environmental asset, but should only use one in the final CBA, as with time-savings. If you wish to include a value for an environmental asset and a value for an educational benefit (using the intermediate good method) then users should calculate only one value for the environmental asset (to avoid duplication of values) and the valuation for education using the intermediate good method.

### 3.2.3 Life and Accident Reduction

CBA Builder Advanced also allows users to estimate life valuations, and the savings made through reductions in accidents. A number of different methods exist for valuing life, and four methods are available to the user in CBA Builder Advanced. These are: (1) forgone earnings; (2) life insurance valuations; (3) the labour market method, and; (4) the consumer purchase method. Accident reduction is based on the DfT's COBA method (see DfT, 2009).

#### *Life Valuation: Forgone Earnings*

The forgone earnings method of estimating the value of statistical life considers the contribution to output, through earnings that will be lost to society as a result of the death of individuals if a project is not undertaken (or as a result of a project).

Using CBA Builder Advanced users enter a value for the average hourly wage rate (national or in a specific industry/occupation depending on the nature of the project in question), the number of lives which are estimated to be saved each year, and the average age of death associated with the focus of the project. Users can enter values for each year from year 0 until year 20. A completed example is shown in Figure 17.

## Valuing life and Accident Reduction

CBA  
Ad

**Life Valuation**

**Forgone Earnings**

	0	1	2	3	4
Wage Rate		£8.50	£9.00	£9.50	£10.00
Number of lives saved		4	5	6	7
Average age of death		57	57	57	57
Annual benefit	£0.00	£455,909.40	£603,409.50	£764,318.70	£938,637.00

**Net Benefit from Lives Saved** **£2,762,274.60**

**Life Insurance Valuations**

Number of lives saved 0

Average life insurance valuation (£) £0.00

**Net Benefit from Lives Saved** **£0.00**

**Labour Market Method**

Average Salary in All Occupations £0.00

Time-Savings  Environment and Education  Life and Accident Reduction  Horizon

Figure 17: Forgone earnings method

In this example life savings are being estimated resulting from the road widening and construction of a set of traffic lights on a particularly dangerous section of road. It is estimated that the number of lives saved will be 4 in year 1, 5 in year 2, 6 in year 3, and 7 in year 4. These have been entered in the relevant fields as can be seen in Figure 17. In the fields above wage rates have been entered for each year. The average age of death of has then been entered, which has been determined by looking at past incidents on the stretch of road and taking the average age of fatalities.

CBA Builder Advanced then estimates a value for the number of lost hours of work associated with these fatalities if the project is not undertaken and estimates a value for each life saved which can be considered the net benefit in lives saved arising from the project.

*Note:* As with the valuations of time-savings and environmental assets, an innovative use of the life and accident reduction tab is that the user can also input negative values if a project is estimated to result in lost lives. Users simply enter negative values for the number of lives saved and this will then calculate a negative net benefit (or cost) associated with the loss of life.

### Life Insurance Valuations

The life insurance valuation method for estimating the value of statistical life uses a simple calculation of the number of lives estimated to be saved as a result of a project, and the average life insurance valuations. The life insurance valuation can be the national average, or could be industry or occupation specific dependent on the exact nature of the project being appraised.

Users simply enter the number of lives estimated to be saved from the project, and the average life insurance valuation. CAB Builder Advanced then calculates the net benefits resulting from the life savings made by the project.

### Labour Market Method

The labour market method compares the relative average salaries of individuals in all occupations against those working in high risk occupations (in a specific occupation if the CBA requires analysis of this). In addition the additional risk of death associated with the higher risk occupation must be estimated by the user to calculate life savings using this method. This method is particularly suitable therefore when analysing specific occupations for a project, or for estimating the value of lives saved as a result of improving conditions in high risk occupations for example.

Using CBA Builder Advanced users enter values for the average annual salary in all occupations, and the average salary in the higher risk occupation or occupations in question. An estimate of the additional risk associated with the occupation must then be entered, for example an additional 1 in 50 risk of death would require the user to enter 50 in the field 'additional risk of high risk occupations' field.

CBA Builder will then produce an estimate for the value of each statistical life. Users then enter value for the number of lives estimated to be saved, and this produces the net benefit associated with life savings using the labour market method. An example is shown in Figure 18.

Labour Market Method		
Average Salary in All Occupations		£26,000.00
Average Salary in High Risk Occupations		£32,000.00
Additional Risk of High Risk Occupations	1/	50
Average Life Valuation		£300,000.00
Number of lives saved		1
<b>Net Benefit from Lives Saved</b>		<b>£300,000.00</b>

Figure 18: Labour Market Method

The salary for the (average) lower risk occupations is estimated as £26,000. The salary for the higher risk occupation is £32,000. The difference in the risk level between the occupations is 1/50, that is there is a 1 in 50 greater chance of death in the higher risk occupation. The average life valuation is calculated as £300,000, and one life is estimated to be saved, giving a net benefit of £300,000. Note

that a greater risk level e.g. 1/10 will result in a smaller valuation with the same difference in salaries. This represents that fact that the individuals are willing to work in the higher risk occupation for the same amount annual salary even though the occupation is even higher risk, therefore suggesting a lower (self) valuation of their lives as they do not require any additional income in order to compensate for the increased risk.

### *Consumer Purchase Method*

The consumer purchase method of valuing statistical life involves the measure of the value of life relative to the purchase of some sort of safety device. For this reason this method is most suitable to use if measuring the value of life relative to the purchase of car with airbags compared to those without, or the cost of purchasing a fire extinguisher for example. Using CBA Builder Advanced users simply enter the cost of the safety measure or device in question, and the reduced risk level associated with the purchase of the device, for example 1/50 or 1/100. CBA Builder then estimates an average life valuation based on this information. The estimated number of lives saved should then be entered by the users to give a value for the net benefit associated with the purchase of the safety device. In the example show in Figure 19 the safety measure in question costs £500, and reduces the risk of fatality by 1/100. It is estimated that 10 lives will be saved through the purchase of this safety measure, giving a net benefit of £500,000.

Consumer Purchase Method	
Cost of Safety Measure	£500.00
Reduced Risk Level	1/100
Average Life Valuation	£50,000.00
Number of lives saved	10
<b>Net Benefit from Lives Saved</b>	
	<b>£500,000.00</b>

Figure 19: Consumer Purchase Method

*Note:* Clearly an important aspect of calculating the value of statistical life using both the labour market and consumer purchase methods is the difference in risk either in different occupations, or in terms of reduced risk after purchasing/implementing a safety measure. The risk level is therefore important to determine prior to performing the CBA, and will require the user to perform some research on to obtain an estimate on this risk value. If estimates are uncertain it may be worth using a number of different risk levels in the final CBA to test the sensitivity of the CBA outcome to the risk level used, as with more standard discount rate sensitivity analyses.

*Accident Reduction (COBA Method)*

Using CBA Builder Advanced users can also estimate savings (or net benefits) made from accident reduction. This could be used to estimate the benefits from reduced accidents after the widening of a road, or the implementation of a new speed limit. This method follows the DfT's COBA method of estimating savings made from accident reduction (see DfT, 2009). This method splits accident reduction into different road types (urban, rural, and motorway) and different levels of severity of accidents (fatal, serious, slight, and damage only). Users can enter values for the numbers of accidents that will be avoided each year from year 0 to year 20, on each type of road and for each type of accident. An example is shown in Figure 20.

**Accident Reduction Valuation (COBA Method)**

Road Type	Accident Type	0	1	2	3	4
Urban	Fatal			1	1	1
	Serious			5	6	6
	Slight			8	9	9
	Damage only			10	11	12
Rural	Fatal					
	Serious					
	Slight					
	Damage only					
Motorway	Fatal					
	Serious					
	Slight					
	Damage only					
<b>Net Benefit from Accident Reduction</b>						<b>£6,599,233.00</b>

Figure 20: Accident Reduction

In the example shown it has been estimated that the road project will result in accident reduction on urban roads in years 2, 3, and 4. The numbers of each type of accident have been entered for each year. Users will need to generate these estimates by either researching other past or similar projects or by generating estimates by looking at accident levels on roads with similar attributes to the road prior to the project, and when the project is completed. CBA Builder Advanced uses the numbers of accidents entered to generate an estimate of the net benefits arising from accident reduction.

**3.2.4 CBA Period Sensitivity Analysis**

CBA Builder Advanced automatically performs an additional form of sensitivity analysis, namely CBA Period Sensitivity Analysis. The CBA Period Sensitivity Analysis is contained within its own tab on the Excel template. It involves CBA Builder Advanced presenting NPV, NPV + H, and BCR values for the CBA period for all possible CBA period lengths that can be analysed using CBA Builder Advanced (i.e. from year zero to year 20). This allows users, for example, to gauge when a project becomes profitable i.e. benefits exceed costs, or when the BCR value of a project becomes a high value project (a BCR value above 2).



## 4 Frequently Asked Questions

### 1 I can't find values for certain costs/benefits. How do I get them?

If values cannot be obtained for certain costs/benefits, which can be the case with environmental impacts especially, you can use CBA Builder Advanced to provide an estimate using one of a range of methods which all come under the broad term 'shadow pricing'. Details of shadow pricing and the range of methods which can be used are contained in this manual, and also on the CBA Builder website ([www.cbabuilder.co.uk/Quant2.htm](http://www.cbabuilder.co.uk/Quant2.htm)).

You may additionally wish to calculate a CBA with and without these estimates to provide an outcome which considers any costs/benefits for which values are uncertain, and one without these costs/benefits included. This will give a more complete picture of the effect of these costs/benefits but also allow interpretation of the results without these more uncertain costs/benefits.

### 2 Why does the Excel cell change to ##### when I enter values for costs or benefits?

If the value you enter is very large – more than £999.9m in the costs and benefits cells then the value is too large to be shown in the cell. The value is still contained in the cell. If you hover over the value or click the cell you will see the value has been entered in the cell. The value will also be included in total costs/benefits and in the results of the CBA, but is just not visible in the cell.

### 3 Why is my horizon value given at the top of the sensitivity analysis tab bigger than the value I calculated on the horizon value tab?

Users can calculate a horizon value using all four methods if they choose, and if this is appropriate given the nature of the project they are appraising, perhaps to compare the different valuations. However, users should note that only one final horizon value can be used to inform the overall results of the CBA (and the sensitivity analysis). The horizon value used in the sensitivity analysis and in the results tab is a total of all the horizon values calculated in the horizon value tab. Users should therefore choose their preferred method and only include this horizon value in their final CBA to avoid this problem.

### 4 Why is the simple projection method horizon value result showing '#DIV/0!'?

A requirement of the simple projection method is that the growth rate must be less than the value of the social discount rate. This is discussed in more detail in a number of texts, for example see Boardman et al (2006, 141-44). To avoid this problem simply ensure that the long term growth rate entered is smaller than the social discount rate. If this is not true for your project an alternative horizon valuation method may need to be used.

### 5 Why does the breakeven social discount rate on the sensitivity analysis tab show '#N/A'?

This is likely a result of a current limitation with the v1.1 versions of CBA Builder Simple and Advanced. The sensitivity analysis tab only calculates the sensitivity of the Net present value of the

CBA to changes in the social discount rate +/- 15% from the social discount rate used. Obviously net minus values for the social discount rate are not useful for interpretation. For example, if a 3% social discount rate is used the values of the sensitivity analysis beyond a -3% change in the social discount rate will not provide useful information for the user.

In the current version a decision was made to limit the positive social discount rate to 15% plus the value of the social discount rate entered as this provides a considerable range of different sensitivity rates. If the CBA result is still positive beyond this point it will result in '#N/A' being given. The user can simply interpret this as showing that the result of the CBA given up to a 15% increase/decrease in the social discount rate does not reach a breakeven rate (i.e. where NPV = 0).

### **6 Why are negative values given in the sensitivity table on the sensitivity analysis tab, and in the sensitivity chart?**

Both the table and chart are automatically generated using the social discount rate the user has entered. The negative values allow the user to enter a social discount rate up to 10% and still produce an accurate and working sensitivity analysis. If a social discount rate entered is lower than this value (which most will be) then the negative values (i.e. the social discount rate entered minus a rate higher than that entered e.g. 3% entered minus 4% will give -1%) should be ignored by the user when interpreting the results.

If you wish to avoid having the negative social discount rate values shown on the chart, simply export the values for the various social discount rates given in the social discount rate table to a new Excel tab (this can be done in CBA Builder), and generate a chart as normal using Excel.

### **7 I want to include the effects of a loss of life or loss of an environmental asset resulting from a project. How do I do this?**

The negative effects of a loss of life or loss of an environmental asset can be accounted for using CBA Builder Advanced. Users can simply enter negative values for the number of lives saved for example. This is described as an alternative use under the relevant sub headings in the life valuations, environmental valuations, and time-savings sections.

## 5 References

Boardman, A., Greenberg, D., Vining, A., Weimer, D. (2001) *Cost-benefit Analysis: Concepts and Practice* (3<sup>rd</sup> Ed.). New York: Prentice Hall.

Department for Transport (DfT) (2009). COBA Manual [online]. Available at:  
<http://www.dft.gov.uk/pgr/economics/software/coba11usermanual/>.

Mishan, E.J. and Quah, E. (2007). *Cost Benefit Analysis* (5<sup>th</sup> Ed.). Oxon: Routledge.

Stiglitz, J. E. (2000). *Economics of the Public Sector*. London: Norton, Chapter 11: Cost Benefit Analysis.

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