

**Incorporating Principles of  
Sustainable Development within the  
Design and Delivery of Major  
Projects: An international study with  
particular reference to Mega Urban  
Transport Projects  
for  
the Institution of Civil Engineers and  
the Actuarial Profession**

**Monetization of environmental and social  
factors in appraisal**

**Omega centre**  
**Centre for Mega Projects in Transport and Development**

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## 1.0 Purpose

This short paper sets out some key issues over the monetization of environmental and social factors in project appraisal. It is intended as a reference for understanding the extent to which such factors might be soundly covered by monetary values in the intended revision of the RAMP handbook.

## 2.0 Sources

Review has been made of the use of monetization as shown by various reports and studies. These include the Literature Review Report prepared for the RAMP project, together with various reports and references, mostly to expert work carried out by academic and consultancy organisations. The three principal sources used in this paper draw out current practice and issues for the UK NATA system, the comparisons and differences across the European Union and practice in North America.

The principal aim has been to identify, in broad terms

- the purpose of monetization
- how monetary values are achieved
- which factors are monetized and which are not
- issues arising from these.

Table 1 (appended) sets out which factors are currently monetized and which are not.

## 3.0 The purpose of monetization

All projects require funding and the use of those funds in one project means that other uses of them are foregone (i.e. that there is an opportunity cost). Large projects obviously demand very large sums, which are necessarily drawn from major funding organisations, including governments and international agencies. In any case most projects look beyond a purely commercial return and thus are very likely to involve some element of public money; an issue which becomes particularly significant for major projects, especially at times of seriously restricted public funding.

In consequence it is essential to identify how effectively funds may be used in projects if finances are to be allocated effectively. Commercial funding bodies will be mostly interested in obtaining the best return in funds as they are typically driven by comparable targets related to commercial rates of return that can be earned elsewhere; this may well involve converting identified values into actual flows of money (e.g. by making charges which users of the planned new infrastructure will pay to save time). Non-commercial organisations, including governments, wish to

identify that the expenditure of finances brings a return that offers 'value for money' and that their overall allocation of public funds is efficient.

Generally the financial return is most appropriate for funding bodies, with some emphasis on those in the private sector. Public funding bodies may also look for this in part, especially where they are acting as trading bodies. In contrast the non-financial return is mostly associated with public sector bodies, where citizen's taxes are used to provide services that would not be provided commercially, or would not be provided commercially; this can also include investment in ways which enable or support provision of non-commercial services. But commercial bodies may also look for a degree of non-commercial benefit from their investment: for example, it might gain them a more dominant position in an area or create a more positive image for them; both would underpin longer term success.

Thus most projects require a measure of what rewards are generated beyond the purely financial ones. To establish this, it is necessary to provide a framework in which all rewards can be assessed on a clear and disciplined basis; i.e. the appraisal system. The types of appraisal system in use range across a spectrum from purely financial to entirely qualitative. However, two principal types of appraisal framework are recognised as:

- Cost Benefit Analysis (CBA), which brings together cash flow for costs and income and summarises them in a single figure, usually Net Present Value (NPV), and
- Multi Criteria Analysis (MCA), in which the impact is set out in tabular form providing a single framework against a set of categories, which may be financial or non-financial.

A hallmark of CBA is that all benefits and all costs are expressed in monetary terms, and are adjusted for the time value of money, so that all flows of benefits and flows of project costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their "present value." Usually this is net present value (NPV) but an alternative measure may be derived: these include PVB (present value of benefits); PVC (present value of costs); NPV (PVB less PVC); NPV/k (where k is the level of funds available); and BCR (benefit cost ratio, PVB divided by PVC).

Obviously it is essential to provide monetary values for all items covered in a CBA. This is not of course necessary for an MCA; however, where monetary values are available, they may be used as a measure for some factors. In some appraisal systems the CBA may in principle form part of the MCA (as e.g. in the Appraisal Summary Table, AST, of the UK NATA system).

Monetization may form an important part of a purely financial assessment where a project is built by a contractor on a Design Build Operate (DBO) or similar arrangement with the main promoter. Both sides will want to establish the value of outputs than might be factored into the contract for payment.

For any use of funds, the alternative use of those funds (opportunity cost) is also a crucial measure. Commercial project promoters, especially from the finance industry, will need to judge whether a project yields the same return as an alternative use of the funds; which might include not only alternative projects but also putting the money into bonds rather than investing it. Governments and other public bodies need to be seen to make best use of taxes; in major projects, including transport and also other investment; also in revenue spending. Thus they need a single comparative measure and funding inevitably forms the primary, perhaps sole, use. The UK Treasury Green Book of 2003 (which is also the basis of much of the NATA system) forms an example.

National governments can at least gain results from such investments within their own country. International agencies, such as the World Bank, however, have a less direct interest and are more concerned with achieving the best set of results from the projects they support both in commercial terms and in contributing to wider and often more long term development objectives.

CBA has been required as a principal means of appraisal largely among the more developed nations and hence monetization has played a larger role in their assessment. Monetization (like other aspects of quantification) is still more widely used in the north west nations of the EU than in the south east ones (HEATCO Del.1); however, it is spreading to other EU nations. No doubt this reflects the need for more sophisticated and transparent assessment in line with developing economic and political aims. It also reflects the requirement by organisations such as the European Investment Bank and the World Bank for disciplined quantification of project components and impacts as a basis for funding projects.

#### **4.0 How monetary values are compiled**

For a straightforward cost assessment, monetary values can in principle be easily compiled. The basis lies in current market values for the various factors (e.g. the purchase cost of steel and concrete or the annual cost of staff to operate the facility), adjusted for circumstances (e.g. forecast trends of real cost increases).

Even physical assets are not necessarily straightforward to value. Litman (2009) in section 4.2 identifies five bases:

- What did it cost?
- What is its market value?
- What is its replacement value?
- What is its performance in use value?
- What is its deprival cost?

Similarly income from operation of the scheme should in principle relatively easy to assess. The potential gain in market terms can be based primarily on monitoring current traffics and in forecast of likely trends. Much of this is usually based on well established practice guidance and data sets.

Assessing the costs of the project in terms of non-financial impacts pose much wider questions over the attribution of monetary values. These range from attribution of values from available data by researchers through to focused questions to members of the public about their values or preferences. Litman (2009) in section 4.3 identifies six formal systems:

1. *Costs*

The total estimated amount of economic losses produced by an impact. For example, the damage costs of traffic crashes include vehicle damages, costs of providing medical and emergency services, lost productivity when people are disabled or killed, plus any non-market costs, such as pain, suffering and grief.

2. *Hedonic Methods (also called "Revealed Preference")*

Hedonic pricing infers values for non-market goods from their effect on market prices, property values and wages. For example, if houses on streets with heavy traffic are valued lower than otherwise comparable houses on low traffic streets, the cost of traffic (conversely, the value of neighbourhood quiet, clean air, safety, and privacy) can be estimated. If employees who face a certain discomfort or risk are paid higher than otherwise comparable employees who don't, the costs of that discomfort or risk can be estimated.

3. *Contingent Valuation (also Stated Preference or Willingness-to-Pay)*

Contingent valuation involves asking people how much they value a particular non-market good. For example, residents may be asked how much they would be willing to pay for a certain improvement in air quality, or acceptable compensation for the loss of a recreational site.

4. *Control or Prevention Costs*

A cost can be estimated based on prevention, control or mitigation expenses. For example, if industry is required to spend \$1,000 per ton to reduce any pollutant emissions we can infer that society considers those emissions to impose costs at least that high. If both damage costs and control costs can be calculated, the lower of the two are generally used for analysis on the assumption that a rational economic actor would choose prevention if it is cheaper, but will would accept damages if prevention costs are higher.

5. *Compensation Rates*

Legal judgments and other compensation rates for damages can be used as a reference for assessing non-market costs. For example, if crash victims are compensated at a certain rate, this can be considered to represent the damages. However, many damages are never compensated, and it would be poor public policy to fully compensate all such damages, since this may encourage some people (those who put a relatively low value on their injuries) to take excessive risks or even to cause a crash in order to receive compensation. As a result, compensation costs tend to be lower than total damage costs.

## 6. *Travel Cost*

This method uses visitors' travel costs (monetary expenses and time) to measure consumer surplus provided by a recreation site such as a park or other public lands.

Different methods are used for the differing items which are monetized. For example, method 1 is particularly used in calculating the costs of casualties resulting from accidents (crashes). But it is not the only way of calculating this. HEATCO Deliverable 1 (2005) shows that, of the 20 nation states which include personal loss for casualties in accident valuation, the basis is:

- Stated Preference / Contingent Valuation – 7
- Costs (production loss) – 4
- Other methods – 5
- SP/CV + Costs – 2
- Costs + another – 2

Items for monetization may include a number of elements and these can differ between systems (and the countries applying them). For example, air pollutants include several well defined and discussed physical properties. But the EU countries which provide a monetary value for air pollution in their CBA use various elements: all of them include PMs but the different systems vary widely in whether they include the other six pollutants considered; and they use four different methods of valuation. For noise all the EU countries which include a value in their CBA use the level of noise, based on hedonic methods, but five also include a component for health impact of noise, based on various methods. (HEATCO Del. 1, part 7)

For most countries in Europe the values recommended in guidance are usually fixed, i.e. they are not increased to reflect changing costs. A very few countries do increase values in line with economic indicators, e.g. France increases them in line with GDP.

The complementary issues of accuracy and precision are *often* given low priority but they are very important. Litman (2009) sets out a definition (section 4.3):

- People involved in economic evaluation should understand the difference between accuracy and precision. Accuracy refers to correctness of information. Precision refers to the level of detail in measurements. A measurement can be very precise but inaccurate. With computers it is easy to calculate analysis with a greater degree of precision than justified by the source data accuracy.
- Non-market cost estimates are often criticized because they lack precision. For example, estimates of air pollution costs may vary by an order of magnitude, depending on the methodology that is used. However, if such impacts are likely to be significant in magnitude, it would be more accurate to incorporate them imprecisely than to omit them in ways that bias results.

## 5.0 Which factors are monetized and which are not

In principle there is an argument that all environmental and social factors may be monetized. Many practitioners point to advances in establishing values (e.g. for NATA in the UK). Critics point to the many gaps remaining. In practice the extent to which factors are monetized varies widely. The broad range is shown in [Table 1](#) (appended), which summarises the situation for the key factors which are set out in the NATA Appraisal Summary Table (AST), considering the UK (NATA), the rest of the EU plus Switzerland (HEATCO Del.1) and North America (Littman, 2009).

The main points to emerge from the table are:

- Some environmental factors are quite commonly monetized. This includes climate change (carbon) and air pollution, and also noise. These essentially consist of physical attributes which can be measured at key points.
- Other environmental factors such as biodiversity and water environment are not monetized. Biodiversity can be identified as consisting of a set of attributes in terms of species present but there is no single set of values.
- Accidents (casualties) are almost always monetized. The change in casualty rates can be derived directly from the changes in numbers forecast to use the transport facility being created by the project (as travellers or traveller kilometres).
- The UK and the USA allocate values to physical fitness. Other European countries appear not to do so.
- Other physical factors – townscape, landscape, heritage – are not monetized.

Beyond this list, other more specifically social factors do not enter into NATA and are not identified as valued in CBAs in other countries.

Two key points emerge:

- Monetization has so far been adopted only where measurement is relatively easy and potentially meaningful.
- Despite growing international cooperation on issues and approaches, the coverage of monetization differs widely. This is even so across nations with a supposedly common economic system and policy approach, such as the EU.

## 6.0 Commentary and conclusions

As the previous section showed, there remain many items which are not monetized. Some commentators would say that this is sensible, since it is simply not possible to establish a meaningful figure for some societal topics, or even for some environmental ones. However, this raises a *serious* problem. Using a simple monetary focus provides in principle for proper comparison for projects within one field and across different fields. In any case the availability of funds is usually a major element in the decision and presentation of monetary values to justify the choice of projects on which to use funds is logical and perhaps essential.

There are however dangers in this. Once monetary values become the key indicators, they may well become the determining factor, even where they are not intended to be. Non-monetary factors are considered within an MCA (e.g. the NATA AST) and they may play an influential role in determining political and management views. However, in the final reckoning they often tend to be left on one side. In commercial circles and in the treasury side of public authorities the NPV or BCR may become the key argument as decision makers seek to be seen to judge on “sound evidence”.

Furthermore, the factors that get monetized tend to be the more accessible ones, such as accidents and physical properties of pollution. Even within these factors there is a tendency to measure the direct effects rather than the indirect ones. In consequence the CBA containing monetary values is actually grounded on a relatively limited set of factors. Generally the “more difficult” ones are not included. Research continues into these (as e.g. for NATA) but with only slow technical advance. On a more general theme, the factors that do get monetized are the more physical and hence measurable ones. In contrast social equity factors rarely get measured: this is either too difficult or perhaps too political. Some environmental factors which require judgement and hence partly reflect social attitudes, such as heritage and landscape, are also not possible to monetize.

Some of the values attributed may themselves be biased. For example, in Stated Preference (Willingness to Pay) surveys, people may not indicate the real impact to themselves; perhaps because they have a limit to what they envisage they might pay. This might especially concern the impact of projects on poorer areas, which may therefore be valued more lightly than richer areas. (One example might be the alignment of the final CTRL (HS1) route through East London and not through Surrey?)

Surveys to obtain values in such circumstances need to be very carefully structured and implemented in order to obtain suitably sound results. In fact the different types of costs and impacts mean that measuring requires different approaches and techniques in various circumstances.

The choice of indicators and the level of information used to monetize them may well be partly determined by the availability of data, the cost of obtaining it and the extent to which it is judged valid. Certainly there are statutory requirements within some fields (e.g. the affordability assessment required in NATA). But these requirements do not necessarily lead to high quality information being generated where this is difficult to achieve.

NATA demonstrates the typical practice of aggregating indicators to provide an apparently easier guidance for decisions. However, the more that data is aggregated, the higher quality it needs to be in principle in order to still be meaningful. Under any circumstances, aggregation means compounding, thus any lack of validity may be increased significantly. And presenting a single set of numerical data – or even just one summary figure – leaves open concerns over how

it was calculated – the ‘black box’ issue. In consequence there is little benefit in implementing a comprehensive system of environmental or social assessment if no check is made on the validity and impartiality of the data presented to the decision makers.

The issue of timescales is also a factor in the use of monetized factors, especially where a single final measure is used. The NPV figure most typically used in CBA is also determined by the discount rate used, related to interest rates for money, so that future costs and prices have a lower value than current ones, more distant costs and prices carry a particularly low weight. This directly contradicts the principle that sustainability is about preparing the world for future generations. A major project generally involves a particularly long timescale.

It may be concluded that the use of monetized values, while significant, also informs decisions in fields which cannot be treated through a monetary approach. This suggests that, to ensure effective treatment of all factors, an approach needs to be found for using monetary values where these are appropriate and soundly based but complementing their use with a well-coordinated appraisal framework which incorporates both monetary and non-monetary criteria, i.e. a Multi Criteria Appraisal.

## References

Department for Transport, (2009), *NATA Refresh: Appraisal for a Sustainable Transport System*, London – [www.dft.gov.uk/webtag](http://www.dft.gov.uk/webtag)

HEATCO, (2005), *Deliverable 1 – Current Practice in Project Appraisal in Europe*, Stuttgart - <http://heatco.ier.uni-stuttgart.de/>

Litman, T, (2009) *Transportation Cost & Benefit Analysis*, Victoria – [www.vtpi.org](http://www.vtpi.org)

OMGEA Centre, (2009), *Literature Review Report*, London

**Table 1**

What environmental and social factors might be **monetizable?** – and what might not? – information from current studies

**NOTE: this table summarises monetization of those factors used in the UK NATA system, those analysed and recommended by the EU HEATCO project (Deliverable 1), and those identified as being established practice elsewhere by Litman (2009). It is not necessarily comprehensive.**

Factor	Country	Sources	Indicator & values used in CBA	Commentary
Climate change	UK	NATA Webtag 3.2	Greenhouse gas (carbon) - £1 per tonne of CO2	CO2 taken as key indicator of carbon
	8 other EU+ countries	HEATCO Del.1	Greenhouse gas (carbon) – € per tonne – mostly C)2	CO2 taken as key indicator of carbon
	17 other EU+ countries	HEATCO Del.1	Costs of various air borne emissions	<b>MONETARY VALUES NOT ASSIGNED</b>
Air quality	UK	NATA Webtag 3.2, 3.3.3	Local air quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Targets exist for levels of defined key pollutants: NOx, PM - Score for assessed change presented in AST
	UK	NATA Webtag 3.2, 3.3.4	Regional air quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Targets exist for levels of defined key pollutants - Score for assessed change presented in AST
	13 other EU+ countries	HEATCO Del.1	Costs of various air borne emissions in €s - NOx, SO2, PM(var), HC, SO	
	10 other EU+ countries	HEATCO Del.1	Costs of various air borne emissions	<b>MONETARY VALUES NOT USUALLY ASSIGNED</b>
	USA	Litman (2009)	Air pollution cost estimates (US-FHA)	By vehicle and road type

		5.10	- US\$\$\$ value per vehicle mile	
<b>Noise</b>	UK	NATA Webtag 3.2, 3.3.2	dB change - £1 per 1dB change	<b>Monetary value calculated but used in AST not CBA</b>
	12 other EU+ countries	HEATCO Del.1	<b>Measures of annoyance / health impact, v. dB scale / change</b>	
	12 other EU+ countries	HEATCO Del.1	dB change	<b>MONETARY VALUES NOT USUALLY ASSIGNED</b>
	USA	Litman (2009) 5.11	Change in noise levels [US-FHA]	<b>MONETARY VALUES NOT ASSIGNED</b> - Assessed change used as basis for design
<b>Landscape</b>	UK	NATA Webtag 3.2, 3.3.7	Quality of landscape	<b>MONETARY VALUES NOT ASSIGNED</b> - Score for assessed change presented in AST - Part of Environmental Capital
<b>Townscape</b>	UK	NATA Webtag 3.2, 3.3.8	Quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Score for assessed change presented in AST - Overlaps with social impact?
<b>Heritage</b>	UK	NATA Webtag 3.2, 3.3.9	Quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Score for assessed change presented in AST - Part of Environmental Capital
<b>Biodiversity</b>	UK	NATA Webtag 3.2, 3.3.10	Quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Score for assessed change presented in AST - Part of Environmental Capital
<b>Water</b>	UK	NATA Webtag	Quality	<b>MONETARY VALUES NOT</b>

<b>Environment</b>		3.2, 3.3.11		<b>ASSIGNED</b> - Score for assessed change presented in AST - Part of Environmental Capital
<b>Physical fitness</b>	UK	NATA Webtag 3.2, 3.3.12	Mortality level - £££ value of reduced mortality from improved fitness	<b>Monetary value calculated but used in AST not CBA</b>
	USA	Litman (2009) 5.2	<b>Health benefits of increased activity (TRB)</b> - <b>US\$\$\$ savings per head</b>	
<b>Journey ambience</b>	UK	NATA Webtag 3.2, 3.3.13	Quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Score for assessed change presented in AST
<b>Accidents</b>	UK	NATA Webtag	<b>Casualty level (risk)</b> - <b>£££ value per casualty saved</b>	- Fatalities / Serious Injuries / Slight Injuries
	All EU+ countries bar 1	HEATCO Del.1	<b>Casualty level</b> - <b>Range: € per casualty saved</b>	- Fatalities / Serious Injuries / Slight Injuries
	USA	Litman (2009) 5.2	<b>Crash costs (US-FHA)</b> - <b>US\$\$\$ value per casualty saved</b>	- Fatalities / Serious Injuries / Slight Injuries
	New Zealand	Litman (2009) 5.2	<b>Crash costs (Land Transport NZ)</b> - <b>NZ\$\$\$ value per casualty saved</b>	
<b>Security</b>	UK	NATA Webtag	Quality	<b>MONETARY VALUES NOT ASSIGNED</b> - Score for assessed change presented in AST