

**USING ENVIRONMENTAL ECONOMICS  
IN DECISION MAKING AND POLICY FORMULATION  
FOR SUSTAINABLE CONSTRUCTION WASTE MANAGEMENT**

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**Abstract**

The UK Government is aiming to increase the amount of construction and demolition waste that is reused and recycled as part of its commitment to a sustainable waste management strategy. Reusing and recycling construction waste reduces the need for raw materials and energy, with corresponding reductions in environmental emissions, aesthetic impacts and damage to natural ecosystems. However, the use of secondary materials also gives rise to environmental and social impacts, particularly in the transport and reprocessing stages. Lifecycle assessment can be used to compare alternative options for the sustainable management of construction waste. Within the assessment, economic valuations of environmental and social impacts provide weightings to enable this comparison.

In the past, waste management decisions have been based primarily on financial cost, and there has been no mechanism for taking environmental and social costs and benefits into consideration. Industry and local authorities are increasingly having to take account of a broader range of criteria, and the discipline of environmental economics provides a means by which these 'external' impacts can be quantified and included in decision making alongside financial costs.

## Introduction

An estimated seventy million tonnes per year (17%) of the UK's waste arises from the construction and demolition industries. Although a large proportion (63%) of the waste created is already 'recycled' most is used for low grade purposes such as access roads within landfill sites, and only 4% is used to replace primary aggregates in more demanding construction uses. As part of a commitment to a sustainable waste management strategy the UK Government has recently introduced a target to increase the reuse and recycling of aggregates in England from 30 to 55 million tonnes per year by 2006<sup>1</sup>.

A number of recent reports examine the potential for recycling construction industry waste<sup>1,2</sup>.<sup>3</sup> These confirm that the disposal route taken is usually the one with the lowest financial cost. There is much potential for increased recycling of construction waste, but there is currently no economic or technical incentive to do so. If it could be demonstrated that the environmental and social benefits outweigh the costs of recycling, and if these benefits could be included in the decision making process, then this would provide a greater incentive to recycle. This effect has been illustrated by the UK landfill tax, which has already gone some way towards providing such an incentive. Industry and local authorities are increasingly turning towards waste reduction and recycling strategies in order to reduce their disposal costs.

Using secondary materials for construction in place of primary materials displaces the environmental and social impacts which would have arisen from primary material extraction and processing. The reduced need for raw materials and energy for extraction and processing correspondingly reduces environmental emissions. Reduced extraction also lessens the aesthetic impact and damage to natural ecosystems.

Although local authorities and the construction industry are being encouraged to recycle, this is not without its own environmental and social impacts, which arise particularly from transporting the materials and in reprocessing them. Transport can be over significant distances, and gives rise to environmental emissions, road congestion and casualties from road traffic accidents.

A technique that can be used to compare the overall level of impacts created by reusing or recycling, with those from landfilling construction waste, is lifecycle assessment (LCA). LCA examines environmental impacts over the entire lifecycle; from obtaining the raw materials, manufacture, distribution, use, re-use/recycling, to final disposal. The overall environmental impact can be determined and alternative options can be compared. We are developing a lifecycle assessment model which takes into consideration the impacts discussed above. The application of economic damage costs to impacts is explored, which allow environmental and social costs and benefits to be included in the decision making process alongside financial costs. Both public and private bodies are being encouraged to take account of a broader range of criteria, and the economic valuation of impacts can thus aid policy formulation for sustainable waste management.

### **Lifecycle assessment methodology**

Lifecycle assessment (LCA) has been used successfully for examining the environmental impacts of products and materials<sup>4</sup>. A limited amount of work has been carried out in applying LCA to waste management<sup>5,6</sup>. However, there has been very little work done in the application of LCA to construction and demolition waste.

The main stages of LCA are goal and scope definition, inventory analysis, impact assessment and the interpretation of results. The goal and scope definition sets the study's boundaries and aims. Setting the appropriate boundaries is not straightforward because each process within the lifecycle is connected to several other processes, which has some impact on the main system. Sensitivity analysis can be used to determine which of these have a significant effect on the main lifecycle and should be included in the LCA.

The inventory analysis is a detailed compilation of all environmental inputs and outputs at each stage of the life cycle. These are presented in terms of quantities of materials and energy required, and outputs of gaseous emissions, liquid effluent and solid waste. In our study we are collecting this data from case studies. Qualitative information, such as visual impact, or raw materials scarcity is difficult to include at this stage.

The inventory data are further analysed in the impact assessment stage. The impact categories are chosen (e.g. greenhouse gases) and the data is aggregated. The relative contribution of each input or output to each environmental impact is then quantified using carbon dioxide equivalents, for example. This results in a 'balance sheet' of impacts for each lifecycle, which provides the basis for comparison.

Unless the outcome is obvious and one lifecycle is better than the other for every impact, it is necessary to apply a system of valuation to the results. In the valuation stage of the impact assessment relative weights are assigned environmental impacts. This enables a comparison of impacts that have been quantified in different units. Valuation remains the most contentious aspect of LCA because the weighting factors involve a subjective element and trade-offs are required between different environmental problems.

## Valuation methodologies

There are various alternative methodologies available for weighting the impacts in the impact assessment stage. The four main approaches can be classified as distance-to-goal techniques, environmental control costs, economic damage approaches or scoring approaches. More details on this can be found in Powell *et al.*<sup>7</sup>.

In our study, we make use of economic damage costs. Economic values are available for a number of different impacts including gaseous emissions, road accident casualties and road congestion (Table 1). They are based on factors such as the number of working days lost through illness, or the cost of repair to acid-rain damaged buildings. They also usually include an assessment of cost based on contingent valuation. This is a technique used by environmental economists involving a questionnaire survey which asks people how much they would be willing to pay to avoid a particular impact occurring. The valuation methodology is then to multiply the economic value by the emission, or the number of expected casualties for example, arising from the entire lifecycle. Alternative options can then be compared.

## Conclusions

Government pledges to increase the sustainability of waste management means that it is necessary for industry and local authorities to base decision making on a broader range of criteria, including environmental and social costs in addition to financial ones. For construction waste, the impacts of alternative management options can be compared within the framework of a lifecycle assessment. Nevertheless, a valuation methodology is required to provide relative weights for the impacts, to be able to make a decision.

Economic valuation is a useful weighting technique, enabling the comparison of different types of impact, such as carbon dioxide emissions versus methane emissions, or even carbon dioxide versus road traffic accidents. Unfortunately, economic valuations do not yet exist for all impacts. Although the valuation of environmental impacts has been used for some time by environmental economists, this technique is new in the field of LCA. However, this economic valuation may appeal to industry because it places environmental costs and benefits on the same scale as financial ones, thus making it easy to include them in the processes of decision making and policy formulation.

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Table 1. Economic Damage Costs

Emission	(£/tonne)	Road	(£/casualty)	
		Casualties		
CO <sub>2</sub>	0.40	Mortality	744,060	
CO	0.60	Serious injury	84,260	
CH <sub>4</sub>	7.20	Minor injury	6,540	
SO <sub>2</sub>	258.40	<b>Road</b>	(pence /PCUkm <sup>b</sup> /HGVUkm <sup>c</sup> )	
		<b>Congestion</b>		
NO <sub>x</sub>	127.00	Motorway	0.26	0.52
N <sub>2</sub> O	61.40	Non central	12.30	24.60
PM10 <sup>a</sup>	898.00	Rural	1.50	2.99

Notes: <sup>a</sup> Particulates less than 10 µm diameter; <sup>b</sup> Passenger car unit kilometre; <sup>c</sup> Heavy goods vehicle unit kilometre.

References: <sup>8,9,10,11</sup>