WRT142 – EVALUATING THE COSTS OF 'WASTE TO VALUE' MANAGEMENT

EXECUTIVE SUMMARY

Introduction

This project responded to the Defra call for research on 'Understanding the True Costs of Waste Management'. The overall aim of the project was to identify the cost components of the nodes and links within various material 'waste-to-value' supply chains[1]. In this context, 'true' costs concern the various combinations of methods, materials, processes and transport through which waste can pass and the resulting financial, environmental and social consequences.

To understand the costs of different waste management options it is necessary to examine the components of cost at each node and link, e.g. detailed energy costs, wage costs, infrastructure costs, material costs, etc. for each particular activity.

Two sets of dynamics give rise to the complexity and variability in the supply channels and their associated costs. Firstly, the impact on costs of organisational objectives and behaviour, targets, demography, politics, material markets and changes in operational costs. Secondly, the inter-relationship between material streams through the various logistic channels. This interlocking nature leads to considerable variability in costs. Variability requires the development of ranges - as opposed to single, stable costs - for every aspect of the cost analysis.

Given the complexity and variability in waste-to-value chains and interactions between material streams, discrete event simulation was employed for the analysis. A modular design approach was devised whereby a base model and hierarchical linked sub-models were developed[2]. This type of time-based simulation enables a model of the waste management system to be developed so that its variability, dynamics and time-based behaviour can be directly addressed and changes in cost components and structure can be evaluated.

As waste management systems are constrained by a wide range of factors - such as bin sizes, the capacities of collection vehicles and processing facilities, and markets - the model includes volumes, and median and modal average values, as well as the standard waste management metric of tonnage mean averages.

Overall, by identifying the variety of routes and the cost components, this research demonstrates both the natural and inadvertent complexity of the 'waste to value' structure and the need for policymakers and managers to understand the **whole** end-to-end 'supply chain' and the top-to-bottom reality of the economic and policy drivers involved.

Outputs – statistics, comments and recommendations

Based on the model calibrated with 2003/04 waste data our analysis of the simulated outputs enabled various outputs and comments to be reported. Amongst them were the following:

Headline statistics

- The overall financial cost for the management of household waste in England was approx. £1.9 billion.
- Financial costs in 03/04 are dominated by residual waste management (£1.5 billion), with an average of £74 per tonne, although recycling supply channels have a higher average cost per tonne (£105) and a total of £379 million. It should be remembered, however, that these are averages only and considerable variation exists between different channels and materials.
- Waste and reprocessing facility costs account for £1.17 billion (62%), whilst transport was estimated to cost £730 million (38%).
- Household collection activities account for 84% of total transport costs.
- Based on our data assumptions the analysis estimates that a total of 248 million km are undertaken in the transport of household waste (excluding car trips to Bring and Civic Amenity (CA) Sites). This

mileage represents 38% of overall costs and results in 13% of total system carbon dioxide equivalent (CO_2e) emissions. Household collection transport is responsible for 47% of this mileage.

- The analysis estimated the CO_2e emissions from household waste management. Total facility emissions, dominated by landfill, are estimated at 2.1m metric tonnes of CO_2e, or 88 kg CO_2e per tonne of waste processed on average. Transport emissions are also important (320,000 tonnes of CO_2e or 13kg CO_2e/tonne processed). Car trips to CA sites are responsible for an estimated 133,000 tonnes of CO_2e (or 24kg CO_2e/tonne processed). Recycling activities are estimated to have a net emissions benefit of nearly 2m tonnes of CO_2e (or 615kg CO_2e/tonne recycled), achieved through the displacement of virgin materials.

Comments

- The layout of the flows and variety of paths for waste materials shows that, based upon best logistical and supply chain management principles, the UK lacks a structure that can be cost effective and efficient. Viewed against good management practices the current system is fragmented by a governing political complexity that is driving dysfunctional actions and uncertain environmental and economic outcomes. In addition to unnecessary complexity, this confused structure and logistics architecture limits any real potential to be derived from economies of scale and the critical mass of material to make rail or other alternative transport modes feasible.
- There are a number of 'supply chain' players – Collection Authorities Disposal Authorities, Defra, other Central Government Departments, waste management companies, waste merchants, and reprocessors each with their own aims, objectives and agendas. Local Authorities are concerned with achieving tonnage targets, whereas reprocessors are more concerned with the quality of the input material. The quality of the material resulting from household tonnage-based targets is frequently not appropriate for domestic markets and, as the cost analyses show, this has a direct impact upon the value chain.
- In most instances the average cost of managing household waste exceeds any average revenues generated in the market. The greater part (71%) of overall costs is disposal to landfill, 48% of which is landfill tax. For recyclables 64% of costs were incurred prior to reprocessing, i.e. from Local Authority budgets. For some local authorities increasing targets and the resultant cost of waste management may require a trade-off between waste and other service provision, particularly as the marginal cost of extracting more material from a decreasing waste fraction increases.
- The supply of waste material for recycling from both commercial and municipal sources significantly exceeds domestic demand as is clearly evidenced by export statistics for waste materials. The project's analysis of costs demonstrates that the continuation of such a reliance on export demand has systemic risk should export quantity decrease, particularly at a time when recycling targets are increasing the supply of material; domestic recycling capacity is decreasing (as seen by the recent closure of many paper mills as a result of increasing energy costs); and UK incineration capacity is severely limited in the short to medium term, for example. the incineration plant at Belvedere has taken more than ten years for approval and is still subject to appeal.
- Financially cost-efficient methods of moving 'waste to value' are not necessarily the most environmentally sound. For example, Bring and CA Sites frequently offer local authorities a cheaper option compared with household collection. However, the CO_2e emissions per tonne of waste from householders delivering waste to CA sites were calculated as five times greater than the CO_2e emissions per tonne of waste from household collection.

Recommendations

- Based upon the design analysis needed to establish the flows and costs it can be seen that the system is not in accord with proven supply chain principles. Indeed, based upon logistics process re-design for a country of the UK's size and demographics, these concepts suggest consideration should be given to establishing one central waste authority that could more effectively address the cost issues and supply chain efficiencies involved.

- In order to meet the requirement of the project to identify the cost components, the holistic treatment of the 'supply chain' processes was essential. As a consequence of this approach in the scoping of the model, the analysis is able to indicate how there are significant and additional benefits to be gained from analysis using good logistics and supply chain principles. For example:

  - Balancing the target-driven supply push and the domestic demand-pull, in terms of quantity and quality.
  - Analysing the sensitivity to, and recognising the risk from, changes to export levels.
  - Exploration of the economies of scale and the critical mass of material that would make rail, inland waterways and offshore shipping more valid options; and the use of alternative fuels to further reduce costs.
  - Investigating the strategic locating of facilities to provide a systematic resource flow process, irrespective of political boundaries.

- The following work should be considered, to build upon this report's findings and the research and design analysis invested in the simulation software:

  - Update the current analysis with data from 2005/06 (already underway).
  - Further develop the analysis of environmental and social non-monetary costs and benefits. It would be possible to place monetary values on externalities e.g. emissions, to investigate and more fully compare 'true' costs of different system and technological options.
  - Explore policy 'levers' at national, regional or local levels and 'what if' scenarios e.g. Regulatory Impact Assessment, Packaging Recovery Notes (PRNs), carbon taxes, Pay as You Throw (PAYT). Best undertaken in liaison with and incorporating other policy analyses.
  - Examine the potential from economies of scale, alternative technologies and transport modes.
  - Examine the elimination of local authority boundaries and the potential for cost reductions.
  - Investigate the transport implications of exported recyclables, i.e. costs, distance and emissions.
  - Explore the potential costs and impact of including and managing household waste with Commercial and Industrial (C&I) waste.
  - At macro-economic level, examine the structure of control, investment rate of return and full 'market' behaviour from a commercially operated waste system with minimal public sector involvement. That is, a study should be undertaken on the basis that the constraints currently imposed by the competing objectives of the public sector are removed; and the consequences of a waste management system managed on commercial grounds subject to normal legal (including environmental) constraints be examined.

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[1] The term 'supply chain' can be misleading in this sense, given the considerable number of ways in which waste actually moves from origin to destination (9,600 basic options). There are no material supply chains as such, but a multiplicity of routes or channels each with significantly different costs for different materials. This is important for policy and cost analysis, particularly in allocating resources to different materials across shared facilities and transport.

[2] The model measured tonnage, volume, financial cost, carbon emissions and transport distance for various materials, and for each supply chain activity. This task required the creation of approximately 3,200 variables to track and measure activities in the system. There are 9,600 possible interlinked supply channels for household waste; and there are four different types of vehicle of six different weight classifications. Approximately 13,500 tonnes of waste require processing per hour of a five day working week. This is handled in our model in 100 tonne entities. So, for every 'real time' hour the model processes 230,040 movements.