



# A multi-criteria decision analysis assessment of waste paper management options

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## ABSTRACT

The use of Multi-criteria Decision Analysis (MCDA) was investigated in an exercise using a panel of local residents and stakeholders to assess the options for managing waste paper on the Isle of Wight. Seven recycling, recovery and disposal options were considered by the panel who evaluated each option against seven environmental, financial and social criteria. The panel preferred options where the waste was managed on the island with gasification and recycling achieving the highest scores. Exporting the waste to the English mainland for incineration or landfill proved to be the least preferred options. This research has demonstrated that MCDA is an effective way of involving community groups in waste management decision making.

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## 1. Introduction

### 1.1. The Isle of Wight

The Isle of Wight is an island off the south coast of England with an area of 381 km<sup>2</sup> and a resident population of 138,500 (2007). It is separated from the mainland by a stretch of water known as the Solent, 4.8 km from Portsmouth and 8 km from Southampton. The island is a major tourist destination, with around one million visitors each year, providing the local economy with an estimated £350 million a year (Isle of Wight Tourism, 2010).

Like other isolated communities, the Isle of Wight has a limited ability to dispose of waste in landfill sites, as well as a national legislature that requires the reduction of biodegradable waste sent to landfill. Furthermore, much of the island is designated as either Sites of Special Scientific Interest (SSSI) or Areas of Outstanding Natural Beauty (AONB) so space for landfill, or any waste-related activity, is restricted. The alternative options are to transport waste away to disposal (or recovery sites in other areas) or to develop local waste management strategies within the area. The fact that the Isle of Wight is a popular tourist destination both adds to the amount of waste generated and the need to find sustainable disposal methods which preserve the environment and the tourist trade within the area. Waste management is a problem that is common to many island communities (Chen et al., 2005) or communities isolated by other barriers such as mountain ranges or long distances.

The Island produces around 87,000 tonnes of municipal waste a year. 31% of this is collected for recycling on the mainland and composting on the island, 52% is landfilled on the island and the remainder is burned in a gasification plant that generates power for the grid system (Defra, 2010). The energy recovery plant was originally a conventional combustion process burning a refuse derived fuel, but this was converted to a gasification plant during 2007/2008. This conversion was part-funded by the Department of Environment Food and Rural Affairs (Defra) under its New Technology Demonstrator Programme (Island Waste, 2009), a scheme designed to promote novel ways of reducing the landfilling of biodegradable wastes. The gasification plant is the first of its kind in the UK and could result in 75% of the island's waste being diverted from landfill (Isle of Wight Council, 2008).

### 1.2. Multi-criteria decision analysis

Multi-criteria Decision Analysis (MCDA) is a process that allows complex qualitative and quantitative information to be evaluated and assessed in a systematic and consistent way while taking account of subjective views of the data and their relative importance (Department for Communities and Local Government, 2009). In summary, in the MCDA process, a panel of people (which can consist of experts, laypersons or a combination of the two) selects the criteria that are important to the decision to be taken (for example, cost, environmental impact, impact on employment), weights the criteria by importance, scores each option (for example landfill, incineration, advanced thermal processing) against each criterion and determines the weighted total score for each option.

The advantages of MCDA are that it is a transparent process that is easily understood by the local community, the objectives and/or

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criteria chosen for the analysis can be analysed and changed if they do not meet the objectives of the analysis and the analysis can provide important information for the decision-makers and the rest of the community about the decision-making process. The disadvantages are the emphasis on the judgement of the decision-making team, where subjectivity can play a significant role and the fact that MCDA cannot show that one decision creates more human welfare than another, the best option possibly being inconsistent with increased welfare leaving the choice of doing nothing as being preferable.

### 1.3. Aim of the research

The aim of this research was to study the use of a simple MCDA process where a group of local residents assessed the options for managing waste paper on the Isle of Wight by considering the financial, environmental and social aspects of a number of materials and energy recovery processes and landfill.

The research was based on paper and card waste for a number of reasons. Firstly, it comprises approximately 30% of all household waste and, being biodegradable, its management is an important factor in meeting the requirements of the Landfill Directive (European Commission, 1993). However, unlike kitchen and garden waste which can be composted at the community or household level, waste paper management is only economically possible at the large scale. Secondly, waste paper can be managed in a number of ways such as materials recycling, energy recovery and composting (when combined with sufficient kitchen and garden waste). Therefore the MCDA technique could be assessed in a robust manner. Finally, it was considered that a study involving the entire waste stream would require the panel participants to assimilate and assess too large a volume of information in a 1-day period.

## 2. Literature review

A widely-stated aim of waste management is to make the process more sustainable (for example European Commission, 2008). Sustainability encompasses more than environmental and financial sustainability; it also includes social sustainability. Therefore, the concerns of society must be taken into account when planning and implementing waste management strategies (van de Klundert and Anschutz, 2000; Kontos et al., 2005). Without social sustainability, a chosen waste management option will be difficult to put into practice in the local community.

### 2.1. Management of waste paper

Waste paper is of particular value to research such as this because it can be managed in several ways. Recycling, thermal processing (by conventional or advanced methods) and landfill are obvious solutions but paper can also be digested or composted when mixed with suitable high nitrogen content wastes. The technologies are all well-established, but there is much debate over the environmental benefits and impacts of the different options. This tends to be invested using life cycle assessment (LCA) singly or in combination with cost benefit analysis and other techniques. Several authors have addressed this issue (Kärnä et al., 1994; Craighill and Powell, 1996; Leach et al., 1997; Grant et al., 2001; Petersen and Andersen, 2002; Dahlbo et al., 2005; Merrild et al., 2008; Burnley et al., 2011). In general, materials recycling was found to be preferable to energy recovery, but this is strongly dependent on the assumptions made about the fuel displaced through implementing energy from waste and on assumptions about forest management. The approach taken by Dahlbo et al. (2005) was interesting in that they identified the optimum solution

for the city of Helsinki. They concluded that 86% of the waste paper should be collected for recycling with the remainder being burned for energy recovery with other residual wastes.

### 2.2. Multi-criteria decision analysis

Multi-criteria Decision Analysis (MCDA) is a process that allows complex qualitative and quantitative information to be evaluated and assessed in a systematic and consistent way while taking account of subjective views of the data and their relative importance. The key features of an MCDA are (Diakoulaki and Grafakos, 2004):

- It involves the stakeholders in the decision making process.
- It acts as an interactive learning process allowing stakeholders to take account of the points of view of other stakeholders.
- It takes a multidisciplinary approach allowing full account to be taken of the complexity of natural systems.
- It allows many criteria to be taken into account, both quantitative and qualitative.

MCDA is widely used by governments in policy making (Jansen, 2001; Department for Communities and Local Government, 2009) and a key guide to MCDA published by the UK Government (Department for Communities and Local Government, 2009) listed a number of features similar to those identified by Diakoulaki and

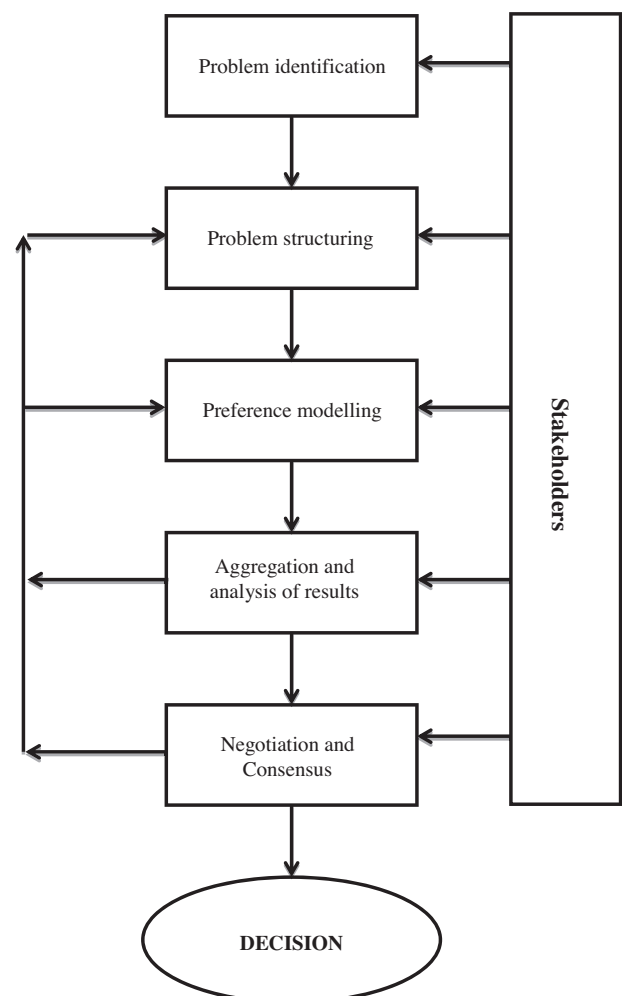


Fig. 1. The MCDA process (Diakoulaki and Grafakos, 2004).

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