Chapter IV
Environmental Criteria in a MCDM Context

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ABSTRACT

This chapter addresses the main issues that are worth considering when using environmental criteria in a multiple criteria decision making (MCDM) context and provides some guidance for a proper and efficient use of environmental criteria in a MCDM context. Among the main issues considered in this chapter, we can mention the definition and representation of criteria, their weighting, and their selection. The relation of criterion to other notions such as attribute, objective, goal, and indicator is also explained. Regarding the environmental criteria, we emphasize their main characteristics and indicate how these characteristics can support the users in selecting appropriate MCDM methods. An illustrative example about the selection of the best scenario for the treatment of a vacuum cleaner at the end of its life cycle is given. It shows the type of reverse supply chain problems in which environmental criteria can be used to evaluate and compare alternatives.

INTRODUCTION

Several factors such as the continuously increasing harm caused to the environment by the industry, the increasing interest of the populations in the environmental issues, and the reinforcement of the regulations regarding the protection of the environment raised the great importance of considering environmental criteria for the evaluation of alternatives in product life cycle decision mak-

ing problems. Consequently, the development and design of products with reduced environmental impact during their whole life cycle is one of the important challenges toward a more sustainable society.

In a recent research work by Palme and Tillman (2007), the authors reported that sustainable development indicators are well used by companies for accounting and reporting purposes, whereas their use in planning and decision making situations is rare despite the importance recognized for the use of sustainable development indicators in planning and decision making.

A product causes negative environmental impacts during each of its life cycle phases. Consequently, the environmental impact of products should be considered throughout their whole life cycle from design until their final destination (recycling, remanufacturing, reuse, incineration, etc.).

The recovery of products when they reach the end of their useful life is a main concern in end-of-life (EOL) product planning and management. The main concept related to the recovery and processing of EOL products is that of reverse supply chain. Among the factors that have favoured the emergence of reverse supply chain as an important research field figures the increasingly constraining legislation with regard to the responsibility of companies toward their products throughout the whole lifecycle, including take-back and recycling. Examples of that are the European Union Directive on Waste Electrical and Electronic Equipment (WEEE Directive) and the European Union Directive on End-of-Life Vehicles (ELV Directive).

The aim of using environmental criteria is to enable the evaluation of environmental impacts both beneficial and harmful of a set of alternatives in a planning or decision making problem (Wang, Yang, & Xu, 2006).

In contrast to the methods addressing only the environmental impact indicators and which are mostly based on the use of impact indicators taken from life cycle assessment (LCA) methods and the cost based models such as cost benefit analysis (CBA), which are based exclusively on minimizing cost or maximizing profit, the MCDM approach considers various types of criteria such as environmental, economic, and social criteria.

Reverse supply chain involves a number of MCDM problems among which we can mention the selection of collection centers and recovery facilities (Pochampally, Gupta, & Gupta, 2004) and the selection of appropriate scenarios for treating EOL products (Bufardi, Gheorghe, Kritsis, & Xirouchakis, 2004).

It is worth recalling that a MCDM problem consists of comparing a number of alternatives (design concepts, materials, manufacturing processes, maintenance strategies, EOL scenarios, etc.) with respect to multiple criteria in order to choose a subset of best alternatives, to rank them from the best to the worst or to sort them according to predefined norms (Roy, 1996).

The comparison of alternatives in a MCDM context can be made according to different types of criteria: environmental, economic, technical, social, institutional, and so forth. Hence, environmental criteria can be considered alone or simultaneously together with other types of criteria. In this chapter, we focus on environmental criteria, even though we will consider their relation to the other types of criteria and we will address some issues related to the concept of criterion in general.

In the past, the MCDM approach suffered from the problem of not being adopted by official organizations. This is now changing positively. Indeed, recently, a number of European Union and United Nations' documents recommended the use of multicriteria analysis for applications where criteria cannot be easily expressed in terms of monetary values (Camper & Turcanu, 2007). According to the same authors, well-known institutions such as the World Bank and the United