MCDA in Analyzing the Recycling Strategies in Malaysia

Santha Chenayah[1], Agamuthu Periathamby[2], and Eiji Takeda[3]

Faculty of Economics and Administration, University of Malaya, Kuala Lumpur, Malaysia
santha@um.edu.my
Institute of Biological Science, University of Malaya, Kuala Lumpur, Malaysia
agamuthu@um.edu.my
Graduate School of Economics, Osaka University, Japan
takeda@econ.osaka-u.ac.jp

1 Introduction

The outranking analysis has been frequently used to deal with the complex decisions involving qualitative criteria and imprecise data (see [5]).

So far, various variants of and PROMETHEE (Preference Ranking Organization METHod for Enririching Evaluations) have also been widely used for the outranking analysis (see, [1]).

This paper demonstrates a new exploitation procedure based on the eigenvector using the "weighted" in- and out- preference flows of each alternative in the outranking analysis of the recycling strategies in Subang Jaya, Malaysia.

The rest of this paper is organized as follows: In the next section, we shall briefly review the preference flows in a PROMETHEE context and a new exploitation procedure based on the eigenvector using the "weighted" in- and out- preference flows of each alternative in the outranking analysis. Section 3 addresses a case study where we shall introduce the 14 recycling strategies (consisting of different combinations of awareness creation rate and increase in recycling facilities) to raise the current recycling (collecting)rate to achieve the national recycling target of 22% by 2020 in Malaysia. Using several criteria, we conducted an outranking analysis, because qualitative criteria and imprecise data are involved in evaluating the recycling strategies. Concluding remarks are given in the final section.

2 Valued Binary Relation and Preference Flows in PROMETHEE

We begin with a brief review of the partial preorder which is a fundamental concept for ranking(see [3]). Let us consider the set A of n alternatives: $A = \{\mathbf{a}_1, \mathbf{a}_2, \dots, \mathbf{a}_n\}$.

Let a valued preference relation π on the set A be a function $\pi : A \times A \rightarrow [0,1]$. In what follows, for any ordered pair $(\mathbf{a}_i,\mathbf{a}_j)$, we shall denote by $\pi(\mathbf{a}_i,\mathbf{a}_j)$ a degree to which the relation between $\mathbf{a}_i$ and $\mathbf{a}_j$ holds.

Definition (partial preorder) A valued binary relation π on A is called a partial preorder if it is reflexive and transitive, where π is called reflexive if $\pi(\mathbf{a}_i,\mathbf{a}_i) = 1$ for $i = 1,2,\dots,n$, and is called transitive if $\pi(\mathbf{a}_i,\mathbf{a}_j) \geq \min\{\pi(\mathbf{a}_i,\mathbf{a}_k), \pi(\mathbf{a}_k,\mathbf{a}_j)\}$ for any $i,j,k = 1,2,\dots,n$.

Let $g_1,g_2,\dots,g_m$ be m-criteria. Thus, each alternatives $\mathbf{a}_i$ is characterized by a multiattribute outcome denoted by a vector $(g_1(\mathbf{a}_i),g_2(\mathbf{a}_i),\dots,g_m(\mathbf{a}_i))$. In what follows, with no loss of generality, we assume that the decision maker prefers larger to smaller values for each criterion. The valued outranking relation $\pi(\mathbf{a}_i, \mathbf{a}_j)$ of $\mathbf{a}_i$ over $\mathbf{a}_j$ which is a valued preference relation is constructed from the notions of quasi-criterion and pseudo-criterion. (see [1]). Thus, $\pi(\mathbf{a}_i, \mathbf{a}_j)$ represents the intensity of the preference of $\mathbf{a}_i$ over $\mathbf{a}_j$ for all the criteria: the closer to 1, the greater the preference. From a valued outranking relation, a valued outranking graph with nodes corresponding to alternatives and arcs $(\mathbf{a}_i, \mathbf{a}_j)$ having values $\pi(\mathbf{a}_i, \mathbf{a}_j)$ is depicted.

Then, in the PROMETHEE method,the preference out-flow and preference in-flow of each node $\mathbf{a}_i$ are respectively defined by

$$\phi^+(\mathbf{a}_i) = \sum_j \pi(\mathbf{a}_i, \mathbf{a}_j), \tag{1}$$

$$\phi^-(\mathbf{a}_i) = \sum_j \pi(\mathbf{a}_j, \mathbf{a}_i). \tag{2}$$

The higher the preference out-flow and the lower the preference in-flow, the better the alternative.

We now extend the preference flows to the "weighted" preference flows which yield the eigenvalue problem:

$$\lambda\psi^+(\mathbf{a}_i) = \sum_{j=1}^{n} \pi(\mathbf{a}_i, \mathbf{a}_j)\psi^+(\mathbf{a}_j), \qquad i = 1,2,\dots,n, \tag{3}$$

where λ is a constant and $\psi^+(\mathbf{a}_j)$ is the weight representing the strength of preference of $\mathbf{a}_j$. This implies that it should be better to outrank a „strong„ alternative than a „weak“ one.

Similarly, we define the weighted preference (in-) flows:

$$\lambda\psi^-(\mathbf{a}_i) = \sum_{j=1}^{n} \pi(\mathbf{a}_j, \mathbf{a}_i)\psi^-(\mathbf{a}_j), \qquad i = 1,2,\dots,n, \tag{4}$$