A RANGE BASED MAMCA TO INCORPORATE UNCERTAINTY IN STAKEHOLDER BASED EVALUATION PROCESSES

Gino Baudry
Université de Nantes, France
LEMNA, Laboratoire d'Economie et de Management de Nantes Atlantique
Chemin de la Censive du Tertre, 44322 Nantes Cedex 3, France
GEPEA, GEnie des Procédés Environnement-Agroalimentaire
CRTT - 37 bd de l'Université, 44602 Saint-Nazaire Cedex, France
Phone : +33 (0)6 45 40 74 62
Email : Gino.Baudry@univ-nantes.fr

Cathy Macharis
Vrije Universiteit Brussel, Belgium
Department BUTO – Business Technology and Operations
MOBI - Mobility, Logistics and Automotive Technology Research Centre
Pleinlaan 2 - 1050 Brussels, Belgium
Phone : +32 (0)2 629 22 86
Email : Cathy.Macharis@vub.ac.be

Thomas Vallée
Université de Nantes, France
LEMNA, Laboratoire d'Economie et de Management de Nantes Atlantique
Chemin de la Censive du Tertre, 44322 Nantes Cedex 3, France
Thomas.Vallee@univ-nantes.fr
Phone: +33 (0)2 40 14 17 72

Overview

The Multi-Actor Multi-Criteria Analysis (MAMCA) is an adequate methodology that explicitly takes into account the preferences of the stakeholders in the decision process. Developed by Macharis in 2000, it has been tested in several applications, mostly in the field of transport and mobility (for an overview see Macharis et al., 2012). As we are mostly working with MAMCA for complex decision problem with often a long term horizon, for some values there might be a range of possible values rather than one single value. It is this type of uncertainty we are dealing with in this paper. This new range based approach will be discussed in the second section of the paper while section 3 will show how such an approach would work out in an illustrative case: the stakeholder support for different biofuel options. As such, it helps decision makers in establishing supportive policy framework to facilitate biofuel implementation.

Methods

The first step of the methodology requires to define the decision making problem and to make a list of possible alternatives. According to the problem, alternatives can take different forms such as site location, technical solutions, policy options or other forms that fit with the need of decision making solutions. Relying on expert's consultations and literature surveys, the present approach consists in constructing indicators to measure alternative's contribution to each criterion.

Addressing long time horizon issues requires anticipating economic, environmental and social issues through different economic sectors. As a consequence, each alternative's contribution to criterion can either be better or worse than initially suggested by the expert assessment. The range based MAMCA proposes to substitute each single value by a probability distribution that captures the different scenarios that can occur for every couple criterion/alternative. Hence the process allows characterizing uncertainties on alternatives that contribute to a given criterion whether the initial data are quantitative or qualitative ones. In the present paper, we use triangular distributions to capture the range of possible values between some pessimistic, some most probable and some optimistic values. By use of a Monte Carlo Simulation (MCS) where each simulation provides a possible state of the world for the different stakeholders, the possible range of solution is generated attributing random performance to each alternative.

The next step of range based MAMCA consists in making a ranking of the identified alternatives considering a given scenario and taking into account the stakeholders' point of views. The process is repeated several times providing a wide range of scenario possibilities as well as wide range of results analysis.

Results

A fictive but realistic case has been chosen on the choice between several biofuel implementation scenarios, namely the choice between first, second or third generation biodiesels. Three actors are considered, namely the biofuel producers, the government and the NGO's, each with three main criteria (based on the Turcksin et al. article (2011) in which a Belgium study case is described). The following graph summarizes the points of view of the three actors for each of the biofuel options. Depending on the uncertainty, the box plots allow possible overlaps in the result between biofuels (Figure 1). For example, the best biofuel producer's alternative can be either FT or conventional biodiesel depending on the performance uncertainty while algae biodiesel can't, whatever its performance's possibilities.

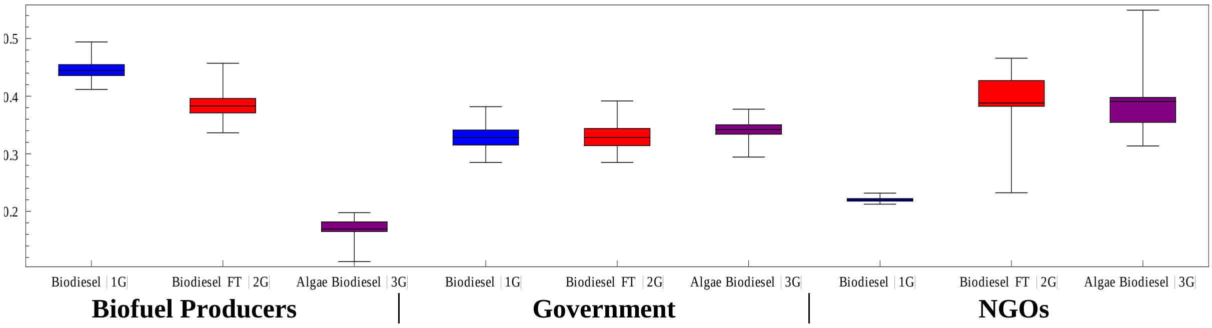

Figure 1 – Stakeholder's final biodiesel ranking (Mathematica ®, 1000 iterations)

The implementation is the final step of the range based MAMCA. According to the previous analysis, an implementation pathway can be designed and additional measures can be established to tackle the socio-economic and environmental barriers and alternative's disadvantages. A policy implementation to support microalgae biodiesel development is considered. According to both multi-actor perspective and biodiesel performance uncertainty, "double counting policy" is identified as a way to satisfy the stakeholders. Apply to microalgae biodiesel, this policy allows supporting high GHG saving technologies development by increasing the potential realistic margin of biofuel producers while reducing the spent of government to reach European renewable energy transport objectives. GHG saving potential describes a high variance, thus the double counting mechanism must imply a minimum threshold to make the microalgae biodiesel a relevant alternative for each stakeholder.

Conclusions

The range based MAMCA helps to take into account a multi-actor perspective in an evolving socio-economical system. By using a MCS, the generation of several set of alternatives' performance takes into account the long time horizon uncertainty. The proposed method also allows finding implementation pathways for alternatives according to their strength, weakness and uncertainty from stakeholder's point of view, making possible to find compensation measures for the ones that are "losing" by the decision. While a classical MCA would have provided a single final ranking, encouraging the support of an alternative which can either be the best or the worst one depending on its performance uncertainty in the long run, the range based MAMCA provides a wide range of possible ranking allowing a much better alternative implementation.

References

Macharis, C., Turcksin, L., Lebeau, K. (2012). Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use. Decision Support Systems, 54(1), 610-620.

Turcksin, L. et al. (2011). A multi-actor multi-criteria framework to assess the stakeholder support for different biofuel options: The case of Belgium. Energy Policy 39, 200–214.