

## **COMBINING PROMETHEE AND AHP: MATCHING THE MEANING OF WEIGHTS**

### **ABSTRACT**

No specific guidelines are provided on how to determine weights in multi-criteria decision analyses with PROMETHEE. Among other weighting methods, the AHP has been proposed as a tool to support the elicitation of weights. However, little attention has been paid to the meaning of the weights derived, and the match of these weights with the model requirements of PROMETHEE. We discuss the diversity in meaning of weights in multi-criteria decision analysis, and proposed recommendations to prevent possible mismatches when combining AHP with PROMETHEE.

Keywords: Weight elicitation, PROMETHEE, AHP

### **1. Introduction**

PROMETHEE pairwise compares the difference in performance of alternatives on each criterion using preference functions that translate the performance differences into a uni-criterion preference score. These uni-criterion preference scores are aggregated into an overall preference score using criterion weights in order to rank the alternatives (Brans & Vincke 1985). While PROMETHEE provides explicit decision analytic support to elicit preferences for the alternatives, it does not support guidance for the elicitation of criterion weights (Macharis, 2004). Nevertheless, it is the responsibility of the decision analyst to fully inform decision makers about the meaning of weights, and to avoid a mismatch between these weights and model requirements (Belton & Stewart 2002). If these requirements are not met, biases could arise (Choo et al. 1999), especially in the case of multiple decision makers.

### **2. Literature Review**

In order to elicit criterion weights for use in PROMETHEE models, the AHP has been frequently applied. Besides the AHP, other methods have been used to elicit weights as well. However, little attention has been paid to the validity of these weights for PROMETHEE models. This may be problematic because depending on the precise elicitation method used, resulting weights have a very specific meaning. Choo et al. listed 13 different plausible interpretations of criterion weights in various MCDA methods (Choo et al. 1999). Each of the definitions would require different information from decision makers to properly estimate the criterion weight for the context of the MCDA method used.

### **3. Hypotheses/Objectives**

In this study we identified the most frequently used methods for weight elicitation, including the AHP, that have been used to complement PROMETHEE analyses. We explored the meaning of the weights derived by these methods, and analyzed the match in meaning of the weights derived by these methods, and weights as required in PROMETHEE models. We proposed recommendations to prevent possible mismatches.

## 4. Research Design/Methodology

From the last ten years, 385 articles were identified in our literature research. These articles were primarily focused on PROMETHEE, were original research studies, written in English, and retrievable by the University library. First, we categorized the methods for weight elicitation used in combination with PROMETHEE, and second, we analyzed the appropriateness of the meaning of the weights derived for the PROMETHEE model following the framework of Choo about the meaning of weights in MCDA.

## 5. Data/Model Analysis

Our literature review showed that 22 per cent of recent PROMETHEE studies did not report their weighting method. The weighting methods that were reported included, in order of decreasing frequency of use, the AHP (24%), direct rating (23%), equal weights (14%), entropy weighting (7%) and preference disaggregation (5%), and others (5%). Many authors commented on the ease of use of applying the AHP for weight elicitation. We identified likely model incompatibilities in terms of discrepant, or unclear meanings of weights.

## 6. Limitations

In a significant proportion of the studies, the meaning of the weights was undefined. This could be explained by a too careless use of weights in decision analytic models. However, the severity of the possible bias and the consequences to the decision made remains unclear. In our future research, we will analyze the meaning of weights and the impact of varying weights on decision outcomes during group decision making.

## 7. Conclusions

In principle, weight elicitation with the AHP can be combined with preference elicitation by means of PROMETHEE. However, to ensure a compatible meaning of the weights for the PROMETHEE model, the range of the performance differences between alternatives needs to be taken into account. In pairwise comparing the criteria, we recommend to explicitly refer to the difference in performance that evokes a strict preference for the higher performing alternative.

## 8. Key References

Choo, E.U., Schoner, B. & Wedley, W.C. (1999). Interpretation of criteria weights in multicriteria decision making. *Computers & Industrial Engineering*, 37(3), 527–541.

Macharis, C. et al. (2004). PROMETHEE and AHP: The design of operational synergies in multicriteria analysis.: Strengthening PROMETHEE with ideas of AHP. *European Journal of Operational Research*, 153(2), 307–317.

Belton, V. & Stewart, T.J. (2002). *Multiple criteria decision analysis: An integrated approach*. 2nd ed., Dordrecht: Kluwer Academic Publishers.