UNCERTAINTY AND COMPATIBILITY IN AHP MODELING: CONSENSUS BUILDING IN PROJECT PORTFOLIO FORMULATION FOR MULTILATERAL ORGANIZATIONS

ABSTRACT

Here we address the practical problem of creating optimal project portfolios for a multilateral organization such as the Global Environmental Facility (GEF). Experience shows that crafting these portfolios can be a challenging and controversial task. Hence, one prerequisite of GEF project portfolios is ensuring the civil society stakeholders' and the academic community's broad participation in evaluating and selecting projects. We develop a framework to evaluate and select the 2014-2018 Mexico's GEF project portfolio. We thus applied the AHP and sensitivity analysis to constructively engage a large group (n=80) of civil society and academia representatives. Results demonstrate that sensitivity analysis is fundamental for settling debates, building consensus, and achieving transparent and technically defensible project portfolios.

Keywords: Group decision making, sensitivity analysis interval judgment, compatibility G-index, climate change adaptation, multilateral organizations

1. Introduction

The Global Environment Facility (GEF) is a multilateral organization to fund development projects with environmental benefits worldwide. The World Bank Group established the GEF after the 1992 Rio Earth Summit. GEF's projects aim to tackle global environmental problems while supporting national, sustainable development, and climate change adaptation initiatives (Biagini *et al*. 2014).

Creating an optimal GEF project portfolio can be challenging and controversial (Streck 2001, Young 1999). One prerequisite is that project portfolios should align the recipient country's priorities with the GEF's mandate to act globally. The portfolios should also complement and reinforce the GEF's obligation to engage with civil society stakeholders. In this regard, the GEF guidelines emphasize transparency and cooperation with civil society and academia. Therefore, GEF project portfolio development requires transparent, accountable, and inclusive approaches for designing project portfolios.

In this paper, we present an AHP and sensitivity analysis implementation to support Mexican environmental authority in developing the 2014-2018 GEF national portfolio. We demonstrate the importance of sensitivity analysis to achieve consensus by synthesizing multiple viewpoints of large groups of experts and stakeholders.

2. Literature Review

Sensitivity analyses in AHP models aim to determine the rank reversal probabilities of criteria or alternatives, given the uncertainty in the hierarchy structure, decision criteria weights, and decision criteria performances. Sensitivity analysis has proved useful for building consensus in decision-making in the context of a large group of experts and decision-makers (Bojórquez-Tapia *et al*. 2005).

3. Objectives

We implemented the AHP and sensitivity analysis to constructively engage civil society and academia representatives in developing a framework for generating an optimal GEF project portfolio.

4. Methodology

We first developed a four-level hierarchy to organize all the decision elements considered in the GEF's 2014-2018 National Portfolio Formulation Exercise. Next, we organized a three-day workshop that gathered 80 experts, authorities, and stakeholders of diverse backgrounds. We equally divided the group into four working tables in the workshop to carry out the required pairwise comparisons for the hierarchy model using the freeware Superdecisions (http://www.superdecisions.com/). We implemented Saaty and Varga's (1987) interval judgment analysis to estimate the rank reversal probabilities among each model's criteria. Finally, we implemented Garuti's (2012) G-index to estimate the compatibility amongst the four models.

5. Model Analysis

Results synthesized 27 criteria of the four-level hierarchical structure analyzed in each of the four working tables. In each working table, all pairwise comparisons attained consistency (C.I.<0.1). The synthesis of the four working tables' output generated the consensus criteria weights (Table 1). These weights resulted from an analytical deliberation session during the workshop. The uncertainty analysis using interval judgment technique and the compatibility analysis of the different aggregations using the G-index helped us build consensus amongst the 80 participants. The interval judgment analysis showed the uncertainty related to integrating the pairwise comparisons of the four working tables. This analysis revealed high-rank reversal probabilities in 17 cases (Table 2).

The results showed two sets of criteria: One composed of criteria repercussion, integration, objective, time term, and focal areas with relatively high global weight ($w \geq 0.05$), and another including the rest of the criteria with relatively low global weights ($w < 0.05$). Likewise, the criteria of the former set presented low-rank reversal probabilities.

The results of the G-index showed low compatibilities of the AHP output between the four-working tables ($0.49 \geq G \geq 0.54$). In contrast, using the geometric mean to aggregate the outputs of the four-working tables, on the one hand, and the interval judgment analysis, on the other hand, resulted in higher compatibility values $0.58 \geq G \geq 0.70$). Furthermore, the compatibility was very high ($G = 0.91$) between the output of the aggregation through the geometric mean and the interval judgment analysis.

Table 1. Hierarchy structure and criteria weights of the AHP model for generating an optimal GEF project portfolio

Criterion			*w*
2nd level	3rd level	4th level	
Compliance (0.630)	Objective		0.255
	Outcome		0.142
	Program		0.142
	Focal area		0.461
Impact (0.185)	Adoption (0.350)	Grow	0.171
		Integration	0.534
		Market	0.191
		Replicability	0.104
	Benefit (0.350)	Repercusión	0.750
		Time term	0.250
	Extent (0.150)	National	0.500
		International	0.250
		Regional	0.250
	Global response (0.150)	Spatial	0.187
		Temporal	0.187
		Objectives	0.628
Contrbution (0.185)	Institutional capacity (0.416)	Government	0.375
		Institutions	0.315
		Regulations	0.310
	Knowledge and information (0.416)	Information	0.085
		Training	0.245
		Knowledge	0.245
		Awareness	0.180
		Monitoring	*0.245*
	Implementation (0.168)	Financial	0.537
		Entities	0.300
		Technology	0.162

6. Limitations

One major limitation of our study was the lack of a real-time feedback procedure. Hence, participants had to recall the previous arguments justifying a particular weight structure. Without immediate feedback from the sensitivity analysis, we had to provide explanations and complicated the analytical deliberation unnecessarily. This limitation prompted us to develop the computer applications to carry out both the interval judgment analysis and the G-index.

Table 2. Rank reversal probability (*p*) between criteria of the AHP model for generating an optimal GEF project portfolio

With respect to	Crriteria	*p*
Goal	Impact-Contribution	0.59
Compliance	Outcome-Program	0.89
	Objective-Program	0.19
	Objective-Oucome	0.16
Impact	Adoption-Benefit	0.89
	Extent-Global response	0.63
Adoption	Grow-Market	0.62
Extent	International-National	0.67
	National-Regional	0.38
Global response	Spatial-Temporal	1.00
Contribution	Institutional capacity-Knowledge/Information	0.51
	Knowledge/Information-Implementation	0.15
Institutional capacity	Institutions-Regulations	0.98
	Government-Institutions	0.73
	Government-Regulations	0.48
Knowledge/Information	Training-Knowledge	0.99
	Training-Monitoring	0.98
	Knowledge-Monitoring	0.95
	Training-Knowledge	0.73
	Training-Awaereness	0.59
	Awereness-Monitoring	0.46
Implementation	Financial-Entities	0.25
	Entities-Technology	0.11

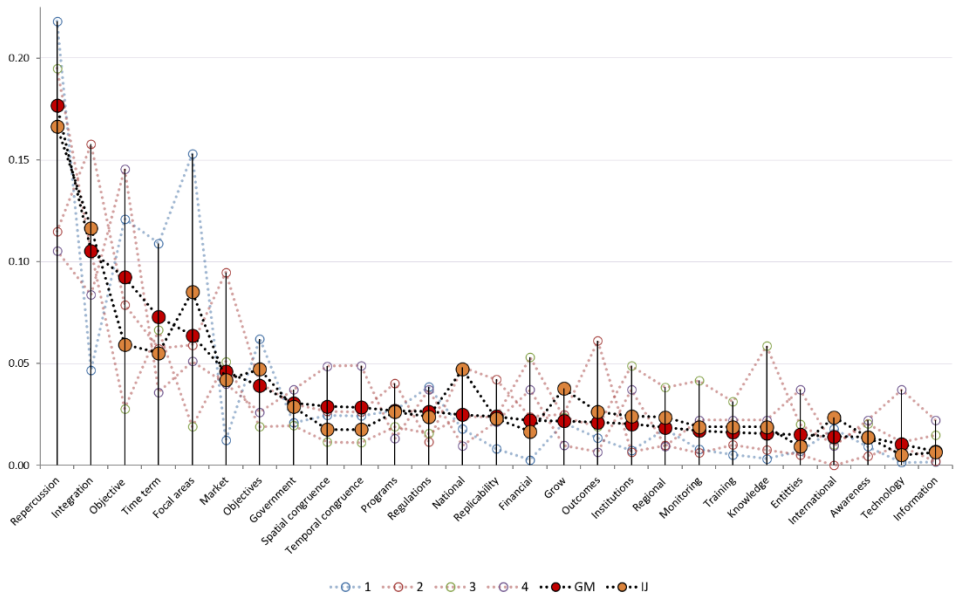

Figure 1. Criteria weights resulting from the four working tables, the aggregation, and the interval judgment analysis

7. Conclusions

We have shown an approach to address the challenges faced by multilateral organizations such as GEF in developing project portfolios in a transparent and accountable way. The implementation of the AHP combined with sensitivity analysis proved fundamental to build consensus among civil society representatives and academia on a general framework to select an optimal project portfolio.

In the Mexican case, the total amount of the projects initially submitted was US$ 468,000,000. The framework was used to consult experts on selecting projects to be included in the GEF project portfolio. The results showed 12 projects (7% of the total) within the high priority category to make up the projects' national portfolio. Together, the total amount of 12 projects for US$ 94,400,000

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