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# **MULTICRITERIA DECISION AIDING IN ORDERING PROJECTS CO-FINANCED BY THE EUROPEAN UNION STRUCTURAL FUNDS\***

## **Abstract**

This paper describes briefly the procedure of evaluation and selection of applications for project co-financing by the European Regional Development Fund that was used in Poland in the period 2004-2006. The paper brings up the issue of improving this procedure by using multicriteria approach based on outranking relations. As an example the problem of ordering projects submitted to Measure 1.2 Environmental Protection Infrastructure by means of ELECTRE methods is presented.

## **Keywords**

Multicriteria decision aiding, European Union Structural Funds, ELECTRE methods.

## **INTRODUCTION**

After entering the European Union on May 1, 2004 Poland has become eligible for support from the EU Structural Funds and the Cohesion Fund. One of the conditions of taking advantage of the opportunity to benefit from transfers from the EU is rational allocation of the financial means depending, among other things, on proper choice of projects that are going to be co-financed. This issue is even more important in the present programming period in which Poland is to receive around 67 billion EUR<sup>1</sup> in regional subsidies from

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<sup>1</sup> As a result of the indexing the total allocation granted to Poland for 2007-2013, i.e. 59,5 billion EUR, by CPI, additional 7,7 billion EUR was gained.

the EU. In order to help the decision-makers in this challenging and difficult task multiple criteria analysis technics can be applied, especially ones based on the outranking relation.

## **1. EUROPEAN UNION REGIONAL POLICY**

The primary objective of the European Union Structural (Regional) Policy<sup>2</sup> is to strengthen the social and economic cohesion of the European Union by means of reducing the disparities in the EU and speeding up the economic convergence of the less-developed regions.

Among the instruments of the European Union Structural Policy there are e.g. Structural Funds and Cohesion Fund. The purpose of the funds is to support the restructuring and modernization of the economies of the member states. They are directed towards those countries and regions that without financial aid cannot achieve the average level of EU economic development [3].

In the programming period 2000-2006 were four structural funds:

- The European Regional Development Fund (ERDF),
- The European Social Fund (ESF),
- The European Agricultural Guidance and Guarantee Fund (EAGGF),
- The Financial Instrument for Fisheries Guidance (FIFG).

The EU Structural Policy is based on four basic principles, namely concentration, programming, additionality, and partnership [3].

The programming concept aims at focussing the member states' efforts on the stable multiannual development programmes which strive for the sustainable solution of the problems of the given region in line with the objectives defined by the EU in each programming period. The previous programming period covered the years 2000-2006, and the current one – the years 2007-2013.

In the programming process each member state has to submit the National Development Plan (NDP) that constitutes the basis for negotiations with the European Commission on the other document – Community Support Framework (CSF). The CSF corresponds to Operational Programmes and contains both the member state's and the Funds' strategy and priorities for action, their specific objectives, as well as the contribution from the Funds and other financial resources [7].

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<sup>2</sup> In the new programming period 2007-2013 it is called Cohesion Policy.

The Community Support Framework for Poland in the years 2004-2006 was implemented with help of seven Operational Programmes:

- Sectoral Operational Programme (SOP) Improvement of the Competitiveness of Enterprises,
- SOP Human Resources Development,
- SOP Restructuring and Modernising Food Sector and Rural Areas Development,
- SOP Fisheries and Fish Processing,
- SOP Transport,
- The Integrated Regional Operational Programme,
- Operational Programme Technical Assistance.

## **2. INTEGRATED REGIONAL OPERATIONAL PROGRAMME**

The Integrated Regional Operational Programme was established to create conditions for the increase of competitiveness of the regions in terms of economic performance, labor productivity, education, innovation, individual income, quality, and quantity of technical infrastructure, as well as to prevent the exclusion of certain specified areas. It aimed at improving the long-term economic development of the country, its economic, social, and territorial cohesion, as well as its integration with the European Union [9].

The following priorities were implemented within the IROP:

- Priority 1 – Development and modernization of the infrastructure to enhance the competitiveness of regions (co-financed by the ERDF),
- Priority 2 – Strengthening the human resources development in the regions (co-financed by the ESF),
- Priority 3 – Local development (co-financed by the ERDF),
- Priority 4 – Technical assistance (co-financed by the ERDF).

An allocation of 4 083,9 million EUR was provided for the implementation of the IROP in the years 2004-2006, out of which 2 968,5 million was from the resources of the structural funds (85,2% from the ERDF and 14,8% from the ESF). The beneficiaries eligible for the support were, first of all, territorial self-government units, their unions, alliances, and associations, but also entities performing public services on the basis of an agreement with territorial self-government units, as well as higher education institutions, schools, health care institutions, and non-profit organizations [10].

The beneficiaries received the support for the realization of concrete projects compatible with the objectives of the appropriate measure of the IROP. The proposals for the projects had to be prepared in the form of an application for co-financing and submitted with required annexes to the proper institution.

### **3. APPRAISAL AND SELECTION PROCEDURE**

The appraisal and selection procedure for the applications applying for co-financing under the ERDF comprised five stages:

1. The formal appraisal of the application made by the competent department of the Marshal Office. The criteria of the formal evaluation involved e.g.: completeness of the application, completeness of the annexes, compliance with the objectives of the measure and with the list of projects provided in the IROP Programme Complement, appropriateness of the sources of finance, eligibility of expenditures.
2. The appraisal by the Panel of Experts as regards all content-related criteria.
3. The recommendation by the Regional Steering Committee to the Voivodship Board.
4. The resolution of the Voivodship Board on project selection.
5. Signing the Agreement Granting Structural Funding with final beneficiary [4].

The Panel of Experts consisted of three persons<sup>3</sup> appraising the projects independently. During the evaluation process the projects were scored according to the criteria approved by the IROP Monitoring Committee and enclosed in the IROP Programme Complement.

The criteria were weighted with the maximum weight 4, the same as the maximum number of points for a given criterion. The score 1 meant that the project was very weakly compatible with the criterion and the score 4, that it was strongly consistent with the criterion. The appraisal of each expert was defined by the weighted sum of the partial scores for specific criteria and the final score of the project was calculated as the arithmetic mean of the scores of all experts participating in the Panel. If the difference between experts' scores for any given criterion amounted to 3 points (before considering its weight) another Panel of Experts appraised the project and its evaluation was binding. As the result of the assessment a ranking list of the projects was drawn up.

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<sup>3</sup> When project's value is in excess of 2 million EUR the fourth expert from the so-called State List can participate in the appraisal process.

The ranking of the projects that were appraised positively, i.e. received at least 60% of points, was submitted to the Regional Steering Committee. The RSC could change the ranking of the projects taking into account their coherence with and the significance for the regional development strategy, as well as their impact on the realization of the region's needs. Afterwards the RSC forwarded the final version of the ranking of projects selected to the Voivodship Board.

On the basis of recommendation of the RSC the Voivodship Board made the final decision on project selection taking into consideration, e.g. the amount of allocation for the voivodship for a given measure, and based on this, could possibly change the RCS' ranking [4].

#### **4. ENVIRONMENTAL PROTECTION INFRASTRUCTURE**

Under the Priority 1 six Measures were implemented. One of them was the Measure 1.2 Environmental Protection Infrastructure. The main aim of this Measure was to improve the quality of the natural environment through: reduction of the amount of pollution emitted into the air, water, and soil; improvement of the flood control conditions; boosting the use of energy from renewable sources; and improvement of environmental management. The additional goals which resulted from the main one were: to raise the standard of living of inhabitants, to increase the investment and tourist attractiveness of the territorial units, and to achieve the environmental standards included in the environmental Directives implemented in Polish law [10].

Within this measure support was provided for infrastructure projects concerned:

- water supply, water intake, and wastewater treatment,
- waste management,
- improvement of the quality of air,
- flood control,
- use of renewable sources of energy

with total value between 4 and 40 million PLN (projects with total cost over 40 million were co-financed from the Cohesion Fund, while these with total value below 4 million were implemented within the IROP Priority 3 Local Development), as well as for projects related to environmental protection management with minimum total value of 1,2 million PLN [9].

Final Beneficiaries of the Measure were: territorial self-government units, their unions, alliances and associations, entities rendering public services in which majority of shares or stock is owned by territorial self-government unit, entities chosen in a public tender procedure conducting public services

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on the basis of an agreement with territorial self-government unit on providing services in the field of environmental protection, administrative government units in voivodship, and units of the public finance sector [10].

Maximum share of ERDF funds in eligible costs of the project amounted to 75%. In the case of investments generating substantial net profit, supplementary financing from the European Union could not exceed 50% while in the case of projects to which the rules of granting the State Aid were applied – 35%.

The content-related appraisal of the projects was made according to the following requirements [9].

Table 1

### Preliminary evaluation

No.	Criteria	Evaluation	
		YES	NO
1	Properly prepared economic analysis of the project	YES	NO
2	Properly prepared financial analysis of the project	YES	NO
3	Legitimacy of the technical solutions	YES	NO
4	Legitimacy and suitable amount of eligible costs	YES	NO
5	Cohesion of the information included in the application and in the annexes	YES	NO

Table 2

### Substantial and technical criteria

No.	Criteria	Weight	Maximum result
1	Impact on realization of accession commitments in the area of environmental protection	4	16
2	Complementarity with other projects (especially with projects funded by the IROP or Cohesion Fund)	1	4
3	Long-term sustainability and institutional feasibility of the project (guarantees the financial stability of the project and sustainability of and institutional structure)	2	8
4	Cost effectiveness of the project	4	16
5	Correctness of indicators	1	4
6	Technical feasibility	1	4
7	Comprehensive projects including projects implemented jointly by more than one self-government unit	2	8
TOTAL			60

## 5. MULTICRITERIA AGGREGATION PROCEDURE

The possibility of ranking the projects with help of arithmetic mean of the weighted scores given by the members of the Panel of Experts seems somewhat illusory, especially in view of uncertainty, inaccuracy, instability, and indefiniteness characteristic for decision-making problems.

An interesting alternative is the approach based on the outranking relations and on the fundamental partial comparability axiom in which incomparability plays a key role. It introduces indifference thresholds and preference thresholds in order to build outranking relations that represent decision-makers' preferences and constitute partial relations of the global preferences. In this kind of approach there is place for incomparability, explained e.g. by the lack of sufficient information to define preferential situation [8]. The procedures exploited according to this approach are usually less demanding for their users at the informational level and result in more balanced recommendations than those belonging to the first approach of a single criterion synthesis [1]. They can definitely improve the procedure of appraising and selecting projects applying for co-financing from the European Union.

## 6. APPLICATION OF THE ELECTRE METHODS TO THE PROJECT SELECTION

Among the procedures based on outranking relations the ELECTRE methods originated by B. Roy and his co-workers stand out<sup>4</sup>. Their usefulness for decision aiding process connected with selection of the projects applying for the support from the European Union Structural Funds will be illustrated by a real-life example of the applications reported in the Measure 1.2 in one of the voivodships in the programming period 2004-2006.

Seven infrastructure projects are considered. All of them deal with the surface water protection and include construction and modernization of wastewater and rainwater collection networks and wastewater treatment plants. Table 3 provides the performance matrix for these seven projects and nine criteria used to evaluate them.

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<sup>4</sup>The precise description of these methods can be found in Roy and Bouyssou [6]. The methodology of multicriteria decision aiding is presented in [5].

Table 3

Values of the criteria for projects

Criteria	Projects						
	A	B	C	D	E	F	G
Capital input [million PLN]	8,42	9,24	9,25	5,93	20,0	26,01	31,55
Net Present Value Ratio	0,0012	0,0003	-0,4621	-0,1825	-0,7935	-0,1208	0,1871
Average annual result measure (direct ecological effect) [g per year]	82 601	373 194	143 036	48 229	183 300	220 424	205 874
Cost efficiency indicator	0,3942	0,5758	0,8828	0,2355	0,2640	0,3206	0,1427
Additional employment [PLN per year]	2 052	2 253	11 484	30 100	129 642	13 853	3 562
Health benefits [PLN per year]	4 564	0	203 577	6 500	0	0	0
Influence on investment attractiveness [PLN per year]	6 735	6 580	179 225	2 000	856 019	0	0
Influence on tourist attractiveness [PLN per year]	20 205	248 312	0	15 000	0	0	0
Number of people using the project	2 000	9 128	1 550	582	3 900	2782	4784

The thresholds and weights are defined in Table 4.

Table 4

Decision-maker's model of preferences

Criteria	Preference's direction	Coefficients of importance	Indifference threshold	Preference threshold	Veto threshold
Capital input	min	0,125	1	3	20
Net Present Value Ratio	max	0,125	0,03	0,15	0,8
Direct ecological effect	max	0,225	10 000	30000	300 000
Cost efficiency indicator	max	0,175	0,03	0,1	0,7
Additional employment	max	0,0625	500	2000	250 000
Health benefits	max	0,0625	500	2000	250 000
Influence on investment attractiveness	max	0,0625	1 000	5000	900 000
Influence on tourist attractiveness	max	0,0625	1 000	5000	900 000
Number of persons using the project	max	0,1	100	500	10000



At the beginning, the ELECTRE I method was used for selecting environmental infrastructure projects<sup>5</sup>.

Tables 5 and 6 present the complete concordance matrix and the discordance set.

Table 5

Matrix of concordance indexes

	A	B	C	D	E	F	G
A	1	0,375	0,4125	0,75	0,55	0,6125	0,4875
B	0,625	1	0,6375	0,75	0,875	0,9375	0,8125
C	0,5875	0,3625	1	0,625	0,55	0,4875	0,55
D	0,25	0,25	0,375	1	0,375	0,375	0,55
E	0,45	0,1875	0,5125	0,625	1	0,475	0,55
F	0,3875	0,125	0,575	0,625	0,65	1	0,775
G	0,5125	0,25	0,5125	0,45	0,575	0,4125	1

Table 6

Discordance set

	A	B	C	D	E	F	G
A	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0
D	0	1	0	0	0	0	0
E	0	0	0	0	0	0	1
F	0	0		1	0	0	0
G	1	1	1	1	0	0	0

An outranking relation exists if the concordance and non-discordance conditions are fulfilled simultaneously. The table below presents the outranking relation for the concordance index not less than 0,6.

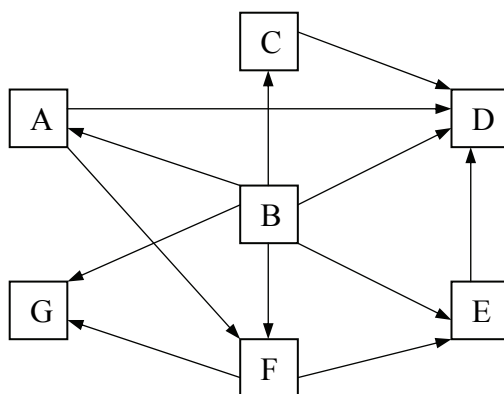
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<sup>5</sup> The procedure is described in [2].

Table 7

Outranking relation for concordance index not less than  $s = 0,6$ 

	A	B	C	D	E	F	G
A	1	0	0	1	0	1	0
B	1	1	1	1	1	1	1
C	0	0	1	1	0	0	0
D	0	0	0	1	0	0	0
E	0	0	0	1	1	0	0
F	0	0	0	0	1	1	1
G	0	0	0	0	0	0	1

Fig. 1. Outranking relation for  $s = 0,6$ 

Tables 8 and 9 show the situation after the increase of the concordance index to 0,625 and 0,65 respectively.

Table 8

Outranking relation for concordance index not less than  $s = 0,625$

	A	B	C	D	E	F	G
A	1	0	0	1	0	0	0
B	1	1	1	1	1	1	1
C	0	0	1	1	0	0	0
D	0	0	0	1	0	0	0
E	0	0	0	1	1	0	0
F	0	0	0	0	1	1	1
G	0	0	0	0	0	0	1

Table 9

Outranking relation for concordance index not less than  $s = 0,65$

	A	B	C	D	E	F	G
A	1	0	0	1	0	0	0
B	0	1	0	1	1	1	1
C	0	0	1	0	0	0	0
D	0	0	0	1	0	0	0
E	0	0	0	0	1	0	0
F	0	0	0	0	1	1	1
G	0	0	0	0	0	0	1

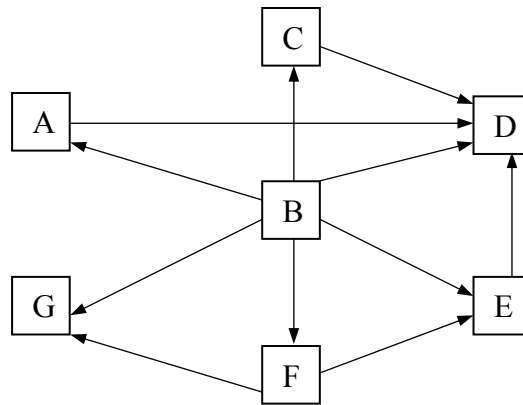


Fig. 2. Outranking relation for  $s = 0,625$

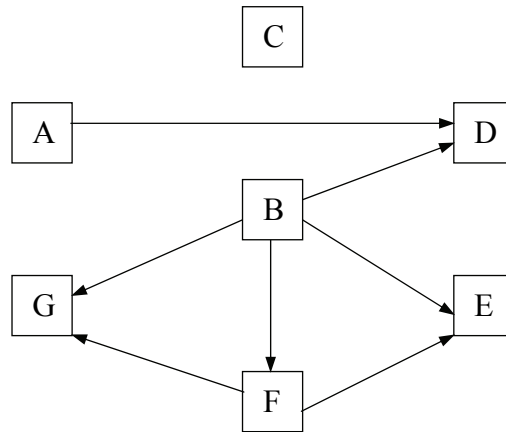


Fig. 3. Outranking relation for  $s = 0,65$

Table 10

The results of graphs' analysis

Level	$s = 0,6$		$s = 0,625$		$s = 0,65$	
	From the best variant to the weakest one	From the weakest variant to the best one	From the best variant to the weakest one	From the weakest variant to the best one	From the best variant to the weakest one	From the weakest variant to the best one
1	B	B	B	B	A, B	B
2	A, C	A	A, C, F	F	D, F	A, F
3	F	F	E, G	A, C, E	E, G	D, E, G
4	E, G	C, E	D	D, G		
5	D	D, G				
					C – isolated	C – isolated

In all cases, project B turned out to be the best and should be recommended for co-financing. According to the results of the graph analysis, project A can also be worth considering as it entered the highest level when the concordance index amounted to 0,65. On the other hand, projects D and G were placed on the lowest level in almost all cases which leads to the conclusion that these are the weakest solutions. Furthermore, taking into account the case of  $s = 0,65$ , project C can be regarded as weakly comparable.

Subsequently, ELECTRE III was applied to order the projects<sup>6</sup>. Table 11 presents the credibility matrix produced for the case study.

Table 11

Credibility matrix

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>
<b>A</b>	1,00	0,01	0,09	0,78	0,07	0,61	0,51
<b>B</b>	0,94	1,00	0,33	0,75	0,40	0,94	0,84
<b>C</b>	0,73	0,12	1,00	0,63	0,30	0,49	0,28
<b>D</b>	0,25	0,00	0,02	1,00	0,06	0,48	0,55
<b>E</b>	0,01	0,00	0,05	0,45	1,00	0,27	0,00
<b>F</b>	0,13	0,01	0,06	0,00	0,09	1,00	0,78
<b>G</b>	0,00	0,00	0,00	0,00	0,07	0,59	1,00

In the next step, two preorders using the descending and ascending distillation were constructed on the basis of the credibility matrix. They are shown in Table 12 together with the final order.

Table 12

Preorders and the final ranking

Descending distillation		Ascending distillation		Final ranking	
class	projects	class	projects	class	projects
1	<b>B</b>	6	<b>B, C</b>	1	<b>B</b>
2	<b>C</b>	5	<b>E</b>	2	<b>C</b>
3	<b>A</b>	4	<b>D</b>	3	<b>A, E</b>
4	<b>F</b>	3	<b>A</b>	4	<b>F, D</b>
5	<b>E</b>	2	<b>F</b>	5	<b>G</b>
6	<b>D</b>	1	<b>G</b>		
7	<b>G</b>				

<sup>6</sup> The description of the procedure can be found in [2].

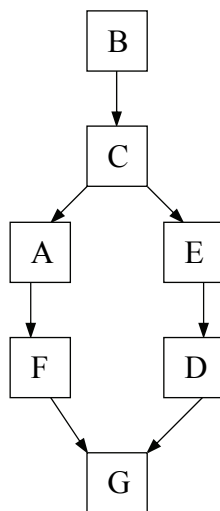


Fig. 4. Final ranking

According to the analysis, project B turned out again to be the strongest and project C was second-strongest. Project G turned out to be the worst variant and could be excluded from the further analysis. Additionally, it is worth mentioning that projects A and F are incomparable with projects E and D.

## CONCLUSIONS

In reality, projects A and C were selected for co-financing as project B did not fulfil one of the formal requirements. Under these circumstances the analysis conducted in the paper proved that the ELECTRE methods can be used for solving the problem of selecting or ordering projects applying for the support from EU Structural Funds. Moreover, their application can enhance the appraisal procedure and improve the decision-making process.

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