BULGARIAN ACADEMY OF SCIENCES

CYBERNETICS AND INFORMATION TECHNOLOGIES · Volume 5, No 1 Sofia.2005

Multicriteria Analysis of Economic Activity for Two Groups of European Countries by Decision Support System MKA-1*

Vassil Vassilev, Sylvia Konstantinova

Institute of Information Technologies, 1113 Sofia E-mails: vvassilev@iinf.bas.bg skonstantinova@iinf.bas.bg

Abstract: This work presents the results obtained from an attempt for multicriteria analysis of the economic activity in 2003 for two groups of European countries: sixteen former socialist countries and sixteen developed European countries. A multicriteria decision support system, developed at the Institute of Information Technologies-BAS, is used. Five macro-economic criteria have been considered in the analysis: GDP per capita; Exports (% of GDP); Imports (% of GDP); Inflation rate (consumer prices); Unemployment rate.

Keywords: multicriteria analysis, decision support system.

Introduction

Multicriteria decision making problems can be divided into two separate classes depending on their formal statement (V i n c k e [17], Y o o n, H w a n g [18]). In the first class a finite number of explicitly set constraints in the form of functions define an infinite number of feasible alternatives. These problems are called continuous multicriteria decision making problems or multicriteria optimization problems. In the second class of problems a finite number of alternatives are explicitly given in a tabular form. These problems are called discrete multicriteria decision making problems or multicriteria analysis problems. The multicriteria analysis problems can be divided into three types: problems of multicriteria choice, problems of multicriteria ranking and problems of multicriteria sorting. Many real life problems in management practice may be formulated as problems of choice, ranking and sorting of resources, strategies, projects, offers, policies, credits, products, innovations, designs, costs, profits, portfo-

^{*} This paper is partially supported by the National Scientific Fund of the Ministry of Education and Science, contract No I/1401/04 "Interactive Algorithms and Software Systems Supporting Multiciteria Decision Making".

lios, etc. (Brooks, Kirkwood [5], Belton [2], Olson [12], French [6], Beinat, Nijkamp [1], Holbourn [8]).

The software systems supporting the solution of multicriteria analysis problems can be divided in two classes – software systems with general purpose and problemoriented software systems. The general-purpose systems developed (Expert Choice (S a a t y [16]), Web-HIPRE (M u s t a j o k i, H a m a l a i n e n [10]), HIVIEW (P e t e r s o n [14]), ELECTRE III-IV (R o y [15]), PROMCALC and GAIA (B r a n s, M a r e s c h a l [3]), Decision Lab (B r a n s, M a r e s c h a l [4]), VIMDA (K o r h o n e n [9]) realize one or several methods from one and the same group of multicriteria analysis methods. Methods from different groups are usually implemented in the problem-oriented software systems. These systems have simplified interface and are built in other information-control systems. One representative of the problemoriented systems, called Agland Decision Tool is discussed in P a r s o n s [13].

Three different methods – the weighting method AHP (S a a t y [16]), the outranking method PROMETHEE II (B r a n s, M a r e s c h a 1 [3]) and the interactive method CBIM (N a r u l a et al. [11]) are applied in the general purpose software system MKA-1, developed at the Institute of Information Technologies-BAS (G e n o v a et al. [7]). The interface modules built in the system enable the successful realization of different types of procedures for deriving information by the DM and also for the entry of different types of criteria – quantitative, qualitative and ranking criteria.

The software system MKA-1 has been used in an attempt for multicriteria analysis of the economic activity for two groups of European countries. The results obtained from this analysis are described in the paper.

Problem description

The multicriteria analysis of the economic activity in 2003 of two groups of European countries – sixteen former socialist countries and sixteen developed European countries is made on the basis of data taken from *The World Factbook* site on Central Intelligence Agency (CIA) (http://www.odci.gov/cia/publications/factbook/). Five macro-economic criteria have been considered in the analysis: GDP per capita; Exports (% of GDP); Imports (% of GDP); Inflation rate (consumer prices); Unemployment rate.

GDP (*Gross Domestic Product*) gives the gross domestic product (value of all final goods and services produced within a nation in a given year). It is used for evaluating the percentage value of the Exports and Imports criteria. The criterion "*GDP per capita*" shows GDP on a purchasing power parity basis divided by population as of 1 July for the same year. The criterion "*Exports*" provides the total US dollar amount of exports on an f.o.b. (free on board) basis. This criterion is in billion dollars. To convert it into % of GDP, the Exports value is divided by the GDP value (it is also in billion dollars). The criterion "*Imports*" provides the total US dollar amount of imports on a c.i.f. (cost, insurance, and freight) of f.o.b. (free on board) basis. To convert it into % of GDP then the Imports value is divided by the GDP value. The criterion "*Inflation rate*" furnishes the annual percent change in consumer prices compared to the previous year consumer prices. The criterion "*Unemployment rate*" contains the percent of the labor force that is without jobs. Substantial underemployment might be

noted. All criteria are quantitative criteria. The first two of them are for maximization and the other three criteria are for minimization.

The following former socialist countries have been taken into account for the analysis: Poland, Czech Republic, Slovakia, Hungary, Slovenia, Bulgaria, Latvia, Estonia, Lithuania, Romania, Albania, Ukraine, Belarus, Serbia and Montenegro, Macedonia, Bosnia and Herzegovina. The developed European countries considered are sixteen, being the following: the United Kingdom, Ireland, Finland, Portugal, Spain, Switzerland, Italy, Germany, France, Belgium, Netherlands, Sweden, Denmark, Austria, Norway, Greece.

Problem solving

The multicriteria analysis of the economic activity of the countries discussed is done with the help of two methods, which are implemented in the software system MKA-1. These methods are AHP and PROMETHEE II. They provide a complete ranking of the alternatives starting from the best towards the worst one.

The basic AHP procedure (S a a t y [16]) consists of the following principles: • construction of the hierarchy and priority setting by pair-wise comparison. A decision problem, centered around an overall objective or focus is structured and decomposed into its constituent parts (sub-objectives, attributes, criteria, alternatives, etc.), using a hierarchy. The topmost level is the focus of the problem. The intermediate levels correspond to criteria and sub-criteria, while the lowest level contains the alternatives. Arranging the sub-objectives, attributes, issues and involving stakeholders in a hierarchy provides an overall view of the complex relationships and helps the decision maker (DM) to assess whether the issues in each level are of the same magnitude so that homogenous elements can be accurately compared. An element in a given level does not have to function as an attribute (or criterion) for all the elements in the level below. The relative "priority" given to each element in the hierarchy is determined by pairwise comparing of the contribution of each element at a lower level in terms of the criteria with which a causal relationship exists. The DM uses a pair-wise comparison mechanism, as the verbal judgements ranging from "equal" to "extreme" correspond to the numerical judgements from 1 up to 9. This procedure is repeated for all subsystems in the hierarchy. The fundamental input to AHP is the DM's answer to a series of questions like "How important is criterion A relative to criterion B?". On the basis of a sequence of such pair-wise comparisons, the relative priorities (weights) are determined, using the eigenvector method. The weights should be seen as the relative contribution of an average score (averaged over all options taken into account) of the elements (of a lower level) to each criterion (of a higher level).

• PROMETHEE II is an outranking method (B r a n s, M a r e s c h a l [4]). The starting point is a data matrix in which the alternatives are evaluated for the different criteria. In the following, the alternatives are compared pair by pair with respect to every single criterion. The results of these comparisons are expressed in a numerical value determined by a Preference function. Multiplying the preferences by the weights

of the criteria and adding the single values, a matrix of global preference of the alternatives is calculated. In this matrix, the sum of the row expresses the strength of an alternative (dominance). The sum of the column expresses to what extent an alternative is dominated by the other ones (subdominance). When the subdominance-value is subtracted from the dominance-value, a linear ranking is obtained. DMs are required to weight indicators and to choose a Preference function. The Preference function translates the difference between the evaluations obtained by two alternatives (a and b) in terms of a particular criterion, into a preference degree, ranging from 0 to 1. For every one of these functions 0, 1 or 2 parameters are given. The indifference threshold defines the size of the difference among the alternatives, at which no preference can be expressed, i.e. appoint the better one. The preference threshold defines the difference between two alternatives, which determines strict preference, i.e. one of them is distinctly better than the other. The value of the Gaussian threshold has to be between the indifference threshold and the preference threshold.

In order to facilitate the selection of a specific Preference function, six basic types have been proposed: Usual criterion, U-shape criterion, V-shape criterion, Level criterion, V-shape criterion with indifference and Gaussian criterion.

Table 1 and Table 2 show the matrices of alternatives for the two groups of countries. The data are for year 2003 and they are taken from *The World Factbook* site on the CIA (http://www.odci.gov/cia/publications/factbook/). Table 1 shows the matrix of alternatives for the sixteen former socialist countries (Problem 1).

Criterion		2003					
	GDP per capita	Exports	Imports	Inflation rate	Unemployment rate		
Alternatives	thousands \$	% of GDP	% of GDP	%	%		
	max	max	min	min	min		
Poland	11.1	15.43	17.07	0.7	20		
Czech Republic	15.7	29.73	32.08	0.1	9.9		
Slovakia	13.3	31.63	32.52	8.6	15.2		
Hungary	13.9	31.34	34.48	4.7	5.9		
Slovenia	19	32.33	34	5.6	11.2		
Bulgaria	7.6	14.83	19.7	2.3	14.3		
Latvia	10.2	14.29	23.34	2.9	8.6		
Estonia	12.3	26.45	35.48	1.3	10.1		
Lithuania	11.4	26.26	30.59	-1.2	10.3		
Romania	7	10.40	13.11	15.3	7.2		
Albania	4.5	2.55	11.47	2.4	15.8		
Ukraine	5.4	10.83	10.83	5.2	3.7		
Belarus	6.1	10.42	12.31	28.2	2.1		
Serbia and Montenegro	2.2	11.66	30.67	11.2	34.5		
FYR Macedonia [*]	6.7	12.30	20.81	1.2	36.7		
Bosnia and Herzegovina	6.1	17.81	64.38	0.9	40		

Table 1

* The former Yugoslav Republic of Macedonia.

Table 2 shows the matrix of alternatives for the sixteen developed European countries (Problem 2).

Table 2					
			2003		
Criterion	GDP per capita	Exports	Imports	Inflation rate	Unemployment rate
	thousands \$	% of GDP	% of GDP	%	%
Alternatives	max	max	min	min	min
United Kingdom	27.7	19.93	23.80	1.4	5
Ireland	29.6	86.46	50.57	3.5	4.7
Finland	27.4	40.58	27.95	0.9	9
Portugal	18	15.93	22.39	3.3	6.4
Spain	22	18.74	23.17	3	11.3
Switzerland	32.7	47.13	43.79	0.6	3.7
Italy	26.7	19.11	18.63	2.7	8.6
Germany	27.6	32.26	27.11	1.1	10.5
France	27.6	22.24	21.82	2.1	9.7
Belgium	29.1	61.03	57.72	1.6	8.1
Netherlands	28.6	57.83	49.73	2.1	5.3
Sweden	26.8	44.56	36.11	1.9	4.9
Denmark	31.1	41.34	35.09	2.1	6.1
Austria	30	36.67	35.84	1.4	4.4
Norway	37.8	45.14	26.96	2.5	4.7
Greece	20	2.90	16.38	3.6	9.4

Solving Problem 1

In order to start each problem, the respective matrix of alternatives is needed and its values are entered in *Initially adding for criteria and alternatives* window of the MKA-1 system (Fig.1). Information of the qualitative and quantitative criteria can be processed as well as the variables that describe the dynamics or some patterns of change.

Criterion Type © Quantitative C Qualitative MinMax	maxGDP per capita(quantitative) maxExports(quantitative) min:Imports(quantitative) min:Inflation rate(quantitative) min:Unemployment rate(quantitative)
Insert Criterion	
Edit Criterion	
liternatives	Poland Czech Republic Slovakia Hungary
Insert Alternative	Slovenia Bulgaria Latvia
	•

When all the necessary data is entered, the method must be chosen from the *View* menu or from *Choose method* window (Fig. 2).

Criterion Type © Quantitative C Qualitative MirMas	maxGDP per capita(qu maxExports(quantitative min:Imports(quantitative min:Inflation rate(quantit min:Linamplon:ment rate Wanning	antitative) e) j) stive) (curantitative)
Insert Criterion	Following alterna	tives are dominated:
Delete Criterion Edit Criterion Wernatives Insert Alternative	Estonia Serbia and Mor Macedonia Bosnia and Her Pole Cze Slov Hun Slov Bug Latv	Methods Analytic Hierarchy Process FROMETHEE II Method Ratition Based Interactive Method Initial Solution Auto generated C Entered by user

Fig. 2

The dominated alternatives can be seen in the Warning window (Fig. 2).

• Solving Problem 1 with AHP method in the first aspect (with equal weights)

In this aspect there are no preferences concerning criteria importance and equal weights are chosen for the pair-wise comparison of the criteria (Fig. 3).

Selative importance of criteria GDP per capita i Exports GDP per capita i Industinate GDP per capita i Industinate GDP per capita i Unemployment rate GDP per capita i Unemployment rate Texports i Industinate Texports I Industinate Texports I Unemployment rate Industion rate	Criterion Criterion 2 98765432123456789 1- equal importance, 3-weak importance, 9- absolute importance, 9- absolute importance, 9- absolute importance
Pn	Fig. 3

After giving information of the preferences for each pair of the criteria, the final alternative ranking in a descending order is obtained (diagram of comparison) (Fig. 4).

	Alternatives	Value of evaluating the function	
1	Czech Republic	0,1993	
2	Slovenia	0,1987	
3	Hungary	0,1702	
4	Lithuania	0,1444	
5	Estonia	0,1232	
6	Slovakia	0,0977	
7	Latvia	0,0597	
8	Poland	0,0543	
9	Ukraine	0,0348	
10	Bulgaria	0,0227	
11	Romania	-0,0472	
12	Albania	-0.0685	
13	Macedonia	-0,11	
14	Belarus	-0,1201	
15	Bosnia and Herzegovina	-0,232	
16	Serbia and Montenegro	-0.2519	

• Solving Problem 1 with PROMETHEE II method in the first aspect (with equal weights and Usual criterion as a Preference function)

The PROMETHEE II method requires additional information for each criterion. In this case equal weights are given for each criterion and Usual criterion is chosen as a Preference function (Fig. 5).

valuation Table	100				2 2.0	Properties of criterion: GDF	P per capita
	GDP per capit		Imports	Inflation rate.	Unemployment rate	Enterion Type	Dura Ballina
Poland	11,1	15,43	17,07	0,7		circitor type	Infrancesive
Czech Republic	15,7	29,73	32.06	0,1		Min/May	Dia in a
Slovakia	13,3	31,63	32,52	8,6	1		Iwaamun
lungay	13,9	31,34	34,48	4,7		Weight	1
Slovenia	19	32,33	34	5.6	1		P.
Bulgaria	7,6	14,83	19,7	2,3	1		
Latvia	10,2	14,29	23,34	2,9		Preference Function	
stonia	12,3	26,45	35,48	1,3	1		Usual criterion
Lithuania	11,4	26,26	30,59	-1.2	1		
Romania	7	10,4	13,11	15,3		Indifference Threshold	May Val - Min
Albania	4,5	2,55	11,47	2.4	1		
Jkrane	5,4	10,83	10,83	5,2		Preference Threshold	16,8
Belarus	6,1	10,42	12,31	28.2			
Serbia and Montenegro	2,2	11,66	30,67	11,2	3	Gaussian Threshold	
Macedonia	6,7	12,3	20,81	1,2	3		
Bosnia and Herzegovina	6.1	17.81	64.38	0.9		Thrashold Link	C Aburlan
Legend	, Quant	itative's Scale			2	Average Performance	9.53
			0 2	in the second			
Min value(rating)	1- Exc 2- Exc 3- Vey 4- Bad 5- Ave	eptionally bad(low) in bad(low) (Low) race(Fair)	w) 6 7 8 9	Good(High) Very good(hig Essential good Exceptionally	h) (high) good[high]	Previous Set V.	alues Solve

Fig. 5

After providing the complete necessary information for each criterion, the final alternative ranking is obtained in a descending order (Fig. 6).

	Alternatives	Value of evaluating the function	
1	Czech Republic	7	
2	Lithuania	5	
3	Hungary	3.8	
4	Poland	2,6	
5	Slovenia	2,6	
6	Estonia	1.8	
7	Latvia	1	
8	Bulgaria	0.6	
9	Ukraine	0.6	
10	Slovakia	0,2	
11	Belarus	-1,6	
12	Romania	-2.2	
13	Macedonia	-2,6	
14	Albania	-42	
15	Bosnia and Herzegovina	-5	
16	Serbia and Montenegro	-9,4	

• Solving Problem1 with AHP method in the second aspect (with different weights)

In this aspect there exist preferences of the criteria importance and different weights are chosen for the pair-wise comparison of the criteria. The criterion GDP per capita is selected as the most important criterion. The next in importance criterion is Exports. The criteria Imports, Inflation rate and Unemployment rate are with equal importance (with equal weights). Fig. 7 shows this pair-wise comparison.

GDP per capita Inflation rate
9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9 1 - equal importance, 3 -weak importance or one over another, 5 - essential or strong importance, 7 demonstrated importance, 9 - absolute importance

Fig. 7

The final ranking obtained after setting the importance of the criteria, is shown in Fig. 8.

	Alternatives	Value of evaluating the function	
1	Slovenia	0,6169	
2	Czech Republic	0,5408	
3	Hungary	0,4996	
4	Slovakia	0,4547	
5	Estonia	0,4229	
6	Lithuania	0,4147	
7	Poland	0,3145	
8	Latvia	0,2942	
9	Bulgaria	0,2286	
10	Ukraine	0,1728	
11	Romania	0,1625	
12	Macedonia	0,1357	
13	Belarus	0,1104	
14	Bosnia and Herzegovina	0,0919	
15	Albania	0,0666	
16	Serbia and Montenegro	-0.0225	m

• Solving Problem 1 with PROMETHEE II method in the second aspect (with different weights and V-shape criterion with indifference as a Preference function)

In this aspect different weights are given for each criterion and a V-shape criterion with indifference is chosen as a Preference function (Fig. 9). The greatest weight value is assigned to the criterion GDP per capita. The next in importance criterion is Exports. Equal weights are chosen for the other three criteria.

valuation Table						Properties of criterion: GDF	per capita
	GDP per capit	Exports			Unemployment rate	Criterion Tupe	Constitution
Poland	11,1	15,43	17,07	0,7		Circlen Type	Turoanokanye
zech Republic	15,7	29.73	32,08	0,1		MeriMax	Maximum.
Slovakia	13,3	31,63	32,52	8,6	1		Ingenun
lungary	13.9	31,34	34,48	4,7		Weight	0.4
lovenia	19	32,33	34	5,6	1		10.4
Bulgaria	7,6	14,83	19,7	2,3	1		less.
atvia	10.2	14,29	23,34	2.9		Preference Function	V Channah in Mi
stonia	12,3	26,45	35,48	1,3	1		Vonape with indit.
Jhuania	11,4	26,26	30,59	-1.2	1		
Romania	7	10,4	13,11	15,3		Indifference Threshold	0.02 Max Val - Mr
Abania	4,5	2,55	11,47	2,4	1		
Jkraine	5.4	10.83	10,83	5.2		Preference Threshold	3 16,8
lelarus	6,1	10,42	12,31	28,2			
erbia and Montenegro	2,2	11,66	30,67	11,2	3	Gaussian Threshold	
Macedonia	6,7	12,3	20,81	1.2	3		
Bosnia and Herzegovina	6,1	17,81	64,38	0,9		Threshold Link	G Abechda
					2	Average Performance	9.53
Legend	Quant	itative's Scale	-			1	
Min value(rating)	1- Exci 2- Ette 3- Very 4- Bad 5- Ave	eptionally bad[lo ential bad[low] : bad[low] (Low] rage[Fair]	4) 6- 7 8- 9-	Good[High] Very good[Hig Essential good Exceptionally	h) (high) good(high)	Previous Set V	alues Solve

Fig. 9

The final ranking obtained after presenting this information for each criterion, is shown in Fig. 10.

	Alternatives	Value of evaluating the function	
1	Switzerland	0,0315	
2	Norway	-0,0111	
3	Austria	-0.0363	
4	United Kingdom	-0,0561	
5	Finland	-0,0673	
6	Sweden	-0,0725	
7	Denmark	-0,086	
8	Ireland	-0.0962	
9	Netherlands	-0,0977	
10	Germany	-0.1202	
11	Belgium	-0,1371	
12	France	-0,1665	
13	Italy	-0,1813	
14	Portugal	-0.2421	
15	Spain	-0,2872	
16	Greece	-0,3106	

The graphical representation of the results for the first and the second aspects relating to Problem 1 is shown in Fig. 11. This representation can be chosen from the *View* menu.







AHP results (in the second aspect)



PROMETHEE II results (in the first aspect)



PROMETHEE II results (in the second aspect)

Fig. 11

Solving Problem 2

• Solving Problem 2 with AHP method in the first aspect (with equal weights) In this case there are no preferences of criteria importance and equal weights are chosen for the pair-wise comparison of the criteria. The final alternative ranking obtained is shown in Fig. 12:





• Solving Problem 2 with PROMETHEE II method in the first aspect (with equal weights and Usual criterion as a Preference function)

Equal weights are given for each criterion and Usual criterion is selected as a Preference function. The final ranking obtained after giving this information for each criterion, is shown in Fig. 13.

	Alternatives	Value of evaluating the function	
1	Switzerland	8,6	
2	Norway	6	
3	Austria	4.8	
4	United Kingdom	2,4	
5	Denmark	2,2	
6	Ireland	1,2	
7	Netherlands	1	
8	Belgium	1	
9	Finland	0.2	
10	Sweden	0,2	
11	Germany	-1,2	
12	France	-1,6	
13	Italy	-3,4	
14	Portugal	-6,2	
15	Greece	-6,8	
16	Spain	-7,8	

Fig. 13

• Solving Problem 2 with AHP method in the second aspect (with different weights)

In this case different weights are set for each criterion with respect to the pairwise comparison. GDP per capita is chosen as the most important criterion. The next in importance criterion is Exports. The criteria Imports, Inflation rate and Unemployment rate are with equal importance (with equal weights). This comparison is shown in Fig. 14. The final ranking obtained after this comparison of the criteria, is shown in Fig. 15.



Fig. 14

1 Norway 0,4433 2 Switzerland 0,4175 3 Ireland 0,3959 4 Austria 0,3402 5 Denmark 0,3342 6 Netherlands 0,3347 7 Belgium 0,3264 8 Finland 0,307 9 Sweden 0,307 10 United Kingdom 0,2786 11 Germany 0,2689
2 Switzerland 0,4175 3 Ireland 0,3959 4 Austria 0,3402 5 Denmark 0,3343 6 Netherlands 0,3347 7 Belgium 0,3264 8 Finland 0,307 9 Sweden 0,307 10 United Kingdom 0,2766 11 Germany 0,2689
3 Ireland 0.3959 4 Austria 0.3402 5 Denmark 0.3354 6 Netherlands 0.3374 7 Belgium 0.3264 8 Finland 0.307 9 Sweden 0.307 10 United Kingdom 0.2766 11 Germany 0.2689
4 Austria 0.3402 5 Denmark 0.334 6 Netherlands 0.3341 7 Belgium 0.364 8 Finland 0.307 9 Sweden 0.3057 10 United Kingdom 0.2766 11 Germary 0.2689
5 Denmark 0,3354 6 Netherlands 0,3347 7 Belgium 0,3264 8 Finland 0,307 9 Sweden 0,3057 10 United Kingdom 0,2786 11 Germany 0,2689
6 Netherlands 0,3347 7 Belgium 0,3264 8 Finland 0,307 9 Sweden 0,3057 10 United Kingdom 0,2786 11 Germany 0,2689
7 Belgium 0,3264 8 Finland 0,307 9 Sweden 0,3057 10 United Kingdom 0,2786 11 Germany 0,2689
8 Finland 0.307 9 Sweden 0.3057 10 United Kingdom 0.2766 11 Germany 0.2689
9 Sweden 0,3057 10 United Kingdom 0,2786 11 Germany 0,2689
10 United Kingdom 0,2786 11 Germany 0,2689
11 Germany 0,2689
12 France 0.229
13 Italy 0,2076
14 Spain 0,1105
15 Portugal 0,088
16 Greece 0.0517

Fig. 15

• Solving Problem 2 with PROMETHEE II method in the second aspect (with different weights and V-shape criterion with indifference as a Preference function)

In this aspect different weights are given for each criterion and a V-shape criterion with indifference is selected as a Preference function (Fig. 16). The greatest weight value is given to the criterion GDP per capita. The next in importance criterion is Exports. Equal weights are chosen for the other three criteria.

valuation 1 abir	2 C				20	Propenses of chienon. GDP	per capita
	GDP per capita	Exports	mporta	Initiation rate U	nemployment rate	Criterion Type	Quantitative
Inited Kingdom	27,7	19,93	23,8	1,4			
eland	29,6	85,46	50,57	3,5	4,7	Min/Max	Maximum
nland	27,4	40,58	27,95	0,9	1		1
ortugal	18	15.93	22.39	3,3	6.4	Weight	0.4
bain	22	18,74	23,17	3	11,2		10
witzerland	32.7	47.13	43.79	0,6	3,		n. 1. d
sly	26,7	19,11	18,63	2,7	8,6	Ptelerence Function	V.Shape with indi
ermany	27.6	32,26	27.11	1,1	10,5		Interest of stage water and the
ance	27,6	22,24	21,82	2,1	9,1		
elgium	29,1	61,03	57.72	1,6	8,1	Indifference I freshold	0,02 Max Val - Min
etherlands	28,6	57,83	49,73	2,1	5,1		
weden	26,8	44,56	36,11	1,9	4.5	Preference Threshold	3 19,8
enmark	31,1	41,34	35,09	2,1	6,1		
ustna	30	36,67	35,84	1,4	4,4	Gaussian Threshold	
orway	37.8	45,14	26,96	2.5	4.3		
reece	20	2,9	16,38	3,6	9,4	Threshold Unit	G Absolute
						Average Performance	27,67
.egend	Qua	ntitative's Sca	le				
Min value(ratin Max value(ratin	g) 1- E: 2- E: 3- Vi 4- B. 5- A:	xceptionally bad ssential bad(low) ery bad(low) ad(Low) xerace(Far)	kw)	6- Good(High) 7- Very good(hig 8- Essential goo 9- Exceptionally	h) (high) good(high)	Previous Set Va	lues Solve

Fig. 16

The final alternative is obtained after providing the necessary information about each criterion (Fig. 17).

	Alternatives	Value of evaluating the function	
1	Norway	8,4656	
2	Switzerland	8.3296	
3	Ireland	5,1081	
4	Denmark	4,5541	
5	Belgium	3,8392	
6	Netherlands	3,4333	
7	Austria	3,1577	
8	Sweden	0,3229	
9	Finland	-0,1022	
10	United Kingdom	-1,1992	
11	Germany	-1,6409	
12	France	-2,2779	
13	Italy	-4,206	
14	Spain	-8,3797	
15	Greece	-9,261	
16	Portugal	-9,3985	

Fig. 17

The graphical representation of the results for the first and the second aspects of Problem 2 are shown in Fig. 18.



AHP results (in the first aspect)



PROMETHEE II results (in the first aspect)



AHP results (in the second aspect)

PROMETHEE II results (in the second aspect) Fig. 18

Conclusions regarding the results. Fig. 18 shows that there are some differences in the arrangements, which are obtained. This is due to the methods used as well as to the different weight (importance) given to the separate criteria. For better evaluation it is necessary to use methods like ELECTRE III or PROMETHEE I, in which group arrangements are obtained. The countries possessing near indicators are ranked in groups.

Conclusion

This work presents an attempt for multicriteria analysis of the economic activity in 2003 for two groups of European countries. This analysis is realized with the help of the software system MKA-1. The arrangements obtained can be used to make conclusions about the economic development of each country in comparison with the other countries from the separate groups.

The fluctuations obtained in the arrangements prove that further elaboration of MKA-1 software system is required, including methods for group arrangements (incomplete arrangements).

References

- 1. B e i n a t, E., P. N i j k a m p. Multi-Criteria Evaluation in Land-Use Management. Dordrecht, Kluwer Academic Publishers, 1998.
- 2. B e l t o n, V. Project Planning and Prioritisation in the Social Services an OR Contribution. Journal of the Operational Research Society, **44**, 1993, 115-124.
- B r a n s, J. P., B. M a r e s c h a l. The PROMCALC & GAIA Decision Support System for Multicriteria Decision Aid. – Decision Support System, 12, 1994, 297-310.
- 4. B r a n s, J. P., B. M a r e s c h a l. How to Decide with PROMETHEE? http://www.visualdecision. Com 2000
- B r o o k s, D. G., C. W. K i r k w o o d. Decision Analysis to Select a Microcomputer Networking Strategy: a Procedure and a Case Study. – Journal of the Operational Research Society, 39, 1988, 23-32.
- Fr e n c h, S. Multi-Attribute Decision Support in the Event of a Nuclear Accident. Journal of Multi-Criteria Decision Analysis, 5, 1996, 39-57.
- 7. Genova, K., V. Vassilev, F. Andonov, M. Vassileva, S. Konstantinova. A Multicriteria Analysis Decision Support System. Proceedings of International Conference "CompSysTech" (B. Rachev, A. Smrikarov, Eds.), Rousse, Bulgaria, IIIA.10-1 – IIIA.10-6, 2004.
- 8. H o l b o u r n, M. Decision Conferencing a Tool for Budget Allocation. Focus on Police Research and Development, May 1998. 10, 1998, 22-23.
- 9. K o r h o n e n, P. A Visual Reference Direction Approach to Solving Discrete Multiple Criteria Problems. – European Journal of Operational Research, **34**, 1988, 152-159.
- 10. M u s t a j o k i, J., R. P. H a m a l a i n e n. Web-HIPRE: Global Decision Support by Value Tree and AHP Analysis. INFOR, **38**, 2000, 208-220.
- N a r u l a, S. C., V. V a s s i l e v, K. G e n o v a, M. V a s s i l e v a. A Partition-Based Interactive Method to Solve Discrete Multicriteria Choice Problems. – Cybernetics and Information Technologies, 2, 2003, No 55-66.
- 12. Olson, D. Decision Aids for Selection Problems. New York, Springer Verlag, 1995.
- P a r s o n s, J. Agland Decision Tool: A Multicriteria Decision Support System for Agricultural Property. – In: Proceedings of iEMSs 2002, Integrated Assessment and Decision Support, 3, 2002, 181-187.

http://www.iemss.org/iemss2002/

- 14. P e t e r s o n, C. R. HIVIEW Rate and Weight to Evaluate Options. OR/MS Today, April, 1994.
- 15. R o y, B. The Outranking Approach and the Foundations of ELECTRE Methods. Theory and Decision, **31**, 1991, 49-73.
- 16. S a a t y, T. S. Highlights and Critical points in the Theory and Application of the Analytic Hierarchy Process. European Journal of Operational Research, **74**, 1994, 426-447.
- 17. V i n c k e, P. Multicriteria Decision-Aid. New York, John Wiley & Sons, 1992.
- 18. Y o o n, K.P., C. L. H w a n g. Multiple Attribute Decision Making. Beverly Hills, Sage, 1995.
- 19. The World Factbook on CIA.

http://www.odci.gov/cia/publications/factbook/