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The MCDA technology and the Oil and gas industry: chronologic analysis

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Abstract: *A few years ago became notorious the inclusion of environmental and social issues in economic decisions, which led to a new strategic framework for organizations. Thus, it is of fundamental importance to know the present limitations and new paradigms in the operational and tactical developing of organizations, aiming at less striking and balanced actions. Thus, the objective was to develop an integrated interpretation of economic, environmental and social issues of the main companies in the oil and gas sectors in the world, featuring their activities through sustainability indicators covered in the three pillars of development (Triple Bottom Line). For the research robustness the decision support multicriteria analysis (AMD) was used as methodology, which in the application of the method ELECTRE III was possible to verify the ranking of companies according to direct sustainable reports. It was concluded that sustainable strategies allied to the Triple Bottom Line are a corporate and operational differential. Thus, it is expected to contribute to the deepening of enterprise policies across all strategic decisions focused on sustainability.*
Keywords: *Multicriteria analysis; Electre III; Oil and gas industry; Sustainability*

I. Introduction

Across the globe, companies are faced with the responsibility not to cause damage to the environment, or at least minimize it. In industrialized nations, more companies are including sustainability in their business; they believe being capable of reducing pollution and increasing profits simultaneously (Hart, 1996). In third world countries, the demands for effective implementation of sustainability have also experienced considerable increase in face of the global view of economic development (Kumah, 2006).

In this context, the number of reports on sustainability performance of companies presented to stakeholders and shareholders has increased in the recent years. One of the key purposes of this report, according to the Global Reporting Initiative (GRI), is to allow a comparison among companies and a performance evaluation for every year (GRI, 2012). This article aims at checking for this possibility, through the use of reports for benchmarking and comparison. It focuses on the important case of the oil and gas industry worldwide, comparing the five largest companies in the period 2005e2011. It also analyzes the year-by-year evolution for each company.

The Multicriteria Decision Analysis (MCDA) was used to obtain the ranking of companies. The MCDA term refers to various methods developed to help decision makers achieve robust and promising results (Loken, 2007), and can be used in various areas, e.g., solid waste management (Karmperis et al., 2013) and assessment of biodiversity conservation (Bottero et al., 2013). Among the existing methods, the ELECTRE III was chosen for reasons that will be detailed in Section 3.

The paper is organized as follows. The first part consists of this introduction, Section 1, followed by detailing the data analyzed, Section 2. In Sections 3 and 4 there is the method description and thereupon the results. Finally, Section 5 shows the conclusion synthesizing the study and results.

II. Data

The top five companies in the oil and gas sector worldwide were analyzed. They account for over 50% of the world oil industry investment (Passuello et al., 2012).

These companies were compared by means of their sustainability reports, all prepared according to the GRI guidelines, version 3 (G3). Aggregate data from reports between 2005 and 2013 were used, i.e. in the nine years preceding the important Macondo accident in 2010. This accident caused major repercussions in the international media and directly impacted one of the selected companies. This company affected by Macondo accident was BP British Petroleum.

The GRI sustainability reports consist of two parts: general information and information on economic, environmental and social indicators. This article made use of the latter one. In G3, the total number of indicators is seventy-nine, but not all companies are obliged to report all of them.

For data selection and comparison of companies, the following steps were followed:

a) The five companies selected were defined according to their market value. Table 1 shows the five largest companies in the oil and gas sector, with their nomenclature and market value.

Table1 - List of the selected companies

Companies	Nomenclature	Market value (million USD - 2010)
Exxon Mobil Coporation	E4	USD 303,30
Royal Dutch Shell	E3	USD 168,00
Petrobrás S.A	E1	USD 147,80
Chevron Corporation	E5	USD 147,20
British Petroleum – BP	E2	USD 116,90

The indicators of environmental performance, economic and social reports of all companies were collected and analyzed regarding the sustainable performance improvement. An important contribution can also be seen in Lang et al. (2007). It is noteworthy that as GRI signatories, they apply the GRI G3 Guidelines for preparing their sustainability reports.
It was sought to compare the evolution of these companies' activities over nine years, i.e. 2005-2013.

Frame 1 - Qualitative weights referring to the criterion EC8

Scale	Impact on the companies' activities
Very high - 5	100% ofcriterionapplication
High - 4	75% ofcriterionapplication
Medium - 3	50% ofcriterionapplication
Low - 2	25% ofcriterionapplication
Verylow - 1	5% ofcriterionapplication

b) The indicators (Frame 2) were selected from the following criteria (Worrall et al., 2009):
i. Relevance to the sector under study;
ii. Contribution to the Triple Bottom Line analysis; and
iii. Reporting and full disclosure by all companies selected.

An important observation can be made for the criterion EC8. This criterion has a qualitative scale as standardization measure, since its weights assigned were given by the scale described in Frame 1.

Frame 2 - Description and relevance of criteria

Criteria	RELEVANCE
Economic	
EC1 - Total production	Data on the creation and distribution of economic value provide a basic indication of how the organization has created wealth for stakeholders.
EC8 - Development and impact of investments in infrastructure and services	The impacts on investments in infrastructure can go beyond the scope of their own organization's business operations and achieve a longer time scale. Thismay include transport connections, publicservices, etc
Environmental	
EN3 - Direct energy consumption is criminated by primary energy source	The organization's ability to efficiently use the energy can be revealed by means of calculating the amount of energy it consumes. Energy consumptionhasdirecteffectonoperatingcosts.
EN8 - Total water withdrawal by source.	The disclosure of the total water withdrawal by source contributes to the understanding of the overall magnitude of potential impacts and risks associated with the water use by the organization.
EN16 - Total direct emissions of greenhouse gases per weight.	Emissions of greenhouse gases are the main cause of climate change. Direct emission is all emissions from sources owned or in the possession of the company.
EN50 - Total indirect emissions of greenhouse gases per weight.	In some organizations, the indirect emissions of greenhouse gases are higher than direct emissions. The changes in their practices can reduce these emissions considerably. Indirect emission is all emissions consequent of the company's activities.
EN20 - SOx, by type and weight	Measures the magnitude of organization's atmospheric emissions and can demonstrate the size and importance of these emissions compared to others.
EN60 - NOx, by type and weight	Air pollutants cause adverse effects on habitats and on human and animal health.
EN21 - Total water discharge by quality and destination.	The volume and quality of water discharged (wasted) by the reporting organization are directly linked to environmental impact and operating costs.
EN22 - Waste total weight	Data on waste generation over the years may indicate the level of progress that the organization has achieved in the effort to reduce waste.
EN23 - Total volume of significant spills.	Accidental spills of chemicals, oils and fuels can have significant negative impacts on the environment, potentially affecting soil, water, air, biodiversity and human health.
EN30- Total investments and expenditures in environmental protection	The measurement of environmental mitigation and environmental protection expenditures allows organizations to assess the efficiency of their environmental initiatives. It also provides valuable

by type	data for cost/benefit internal analysis.
SOCIAL	
LA1 - Total workforce by employment type, employment contract and region.	The size of the workforce provides an overview of the extent of impacts generated by labor issues.
LA7 - Rates of work-related deaths	The safety and health performance is a key measure of the duty of care to na organization.
LA70 - Rates of work-related occupational illnesses by region.	Health management practices that result in a number of minor incidents at work.

c) The standardization of measures for each criterion followed a logic that can be seen in Frame 3. The economic and environmental criteria were normalized to the amount produced, i.e. the total annual production, which encourages the company's economic expansion and establishes a magnitude comparison between them. The social criteria were normalized according to the total number of employees in the particular year, company, since these criteria are of major impact on life quality of workers and families.

Frame 3 - Criterianormalized

Criteria	**Normalization**
Economics	
EC1 - Total production	10^3oil/day
EC8 - Development and impact of investments in infrastructure and services	Qualitativeweight
Environmental	
EN3 - Direct energy consumption is criminated by primary energy source	TJ/barrels/year
EN8 - Total water withdrawal by source.	10^3 $m^3/10^3$barrels/year
EN16 - Total direct emissions of greenhouse gases per weight.	$Mt/10^3$barrels/year
EN50 - Total indirect emissions of greenhouse gases per weight.	$Mt/10^3$barrels/year
EN20 - SOx, by type and weight	$t/10^3$barrels/year
EN60 - NOx, by type and weight	$t/10^3$barrels/year
EN21 - Total water discharge by quality and destination.	103 $m^3/10^3$barrels/year
EN22 - Waste total weight	$t/10^3$barrels/year
EN23 - Total volume of significant spills.	$m3/10^3$barrels/year
EN30- Total investments and expenditures in environmental protection by type	10^3 $USD/10^3$barrels/year
Social	
LA1 - Total workforce by employment type, employment contract and region.	10^3employees
LA7 - Rates of work-related deaths	(A)/employees
LA70 - Rates of work-related occupational illnesses by region.	$rate/10^4$person hours

d) The purpose of each criterion can be observed in Frame 4. These objectives are of paramount importance for the correct application of the ELECTRE III method.

Frame 4 - Objective of each criterion

Criteria	**Objective**
EC1	Maximize
EC8	Maximize
EN3	Minimize
EN8	Minimize
EN16	Minimize
EN50	Minimize
EN20	Minimize
EN60	Minimize
EN21	Minimize
EN22	Minimize
EN23	Minimize
EN30	Maximize
LA1	Maximize
LA7	Minimize
LA70	Minimize

III. Method

The multicriteria approaches propose ways to model the decision-making processes, including items such as type of decision to be made, unknown events that may affect the results, possible courses of action and the results themselves. The multicriteria are also used to measuring the sustainability (Tosicey al., 2015; Castellini et al., 2012) and others scientific areas. Among the most robust multicriteria methods, the specific methodology of ELECTRE Family stands out (Roy, 1985).

1.1 ELECTRE III

Within the ELECTRE family, the method chosen was ELECTRE III that allows the use of inaccurate, indefinite and uncertain criteria, inherent to complex processes in human decision, based on the use of pseudo-criteria and thresholds of preference and indifference. Moreover, the "very bad" performance in one criterion that cannot be offset by good results in other criteria depending on the veto threshold. ELECTRE III has been widely used. In order to exemplify it, some practices are applied: in classification problems, for example, in the ranking of actions for investments selection (Huck, 2009), the choice for a strategic sustainable management of demolition waste (Roussat et al., 2009), energy systems selection (Tosic, et al., 2015; Cavallaro, 2010), housing evaluation (Natividade-Jesus et al., 2007), environment and management of water consumption (Mushtaq Khan, et al., 2015;Giner-Santonja et al., 2012; Hanandeh and El-Zein, 2010), finance (Zhelev, 2014; Li and Sun, 2010), decision analysis (Infante, et al., 2013;Montazer et al., 2009), education (Giannoulis and Ishizaka, 2010) and others (Bana e Costa and Oliveira, 2012; Durbach and Stewart, 2012; Frini et al., 2012). However, it has not been applied to the ordination and performance evolution analysis of the greatest oil and gas industries worldwide.

The ELECTRE III depends on the construction and exploitation of some relationships. Its phases are depicted in Fig. 1.

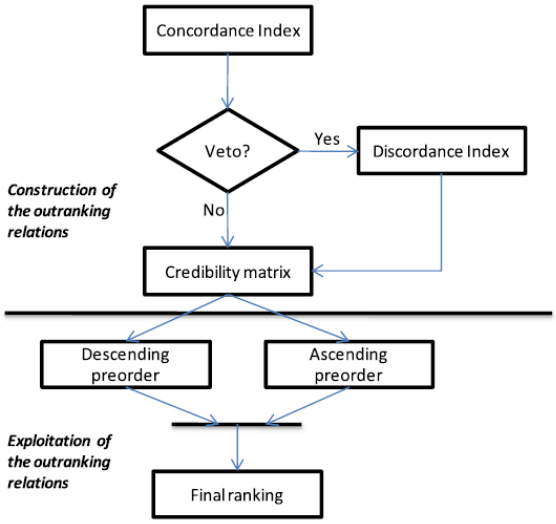

Fig. 1 - Electre III flow

- Construction of the outranking relationship: the performance alternatives (the five companies under study) are pairwise compared (A, B). Each pairwise is characterized by an overcome relationship. Establish that "the alternative A outperforms alternative B" means "alternative A is at least as good as alternative B". There are three overcome relationships: "indifferent," "weakly preferred" or "strictly preferred", according to the difference between the performance alternatives and thresholds given by the decision maker.
- Exploitation of the outranking relationship: two preclassifications are then constructed with two antagonist procedures (upward and downward distillation). The combination of the two pre-classifications provides the final classification.

1.2 Constructing the outranking relationships

1.2.1 Pseudo-criteria

The simplest and most traditional criterion is called 'true criteria'. These have no defined limits. Only the difference among criteria scores is used to determine which option is the preferred one. Pseudo-criteria are used in order to take into account the inaccuracy and uncertainty in indeterminacy in complex decision problems. The indifference q and preference p thresholds allow the construction of a pseudo-criterion. Thus, three alternative relationships between alternatives A and B can be considered:

a) A and B are indifferent if the difference between the performance of two alternatives issmaller than the threshold indifference. The indifference between alternatives is denoted as A **I** B.
   A **I** B if; and only if; $z(A) - z(B) \leq q$ (1)
   where, z(X): alternative X performance; q: indifference threshold.
b) Alternative A has weak preference compared to alternative B if the difference between their performances is between the thresholds of indifference and preference. The notation for weak preference is A **Q** B.
   A Q B if; and only if; $q < z(A) - z(B) \leq p$ (2)
   where, z(X): alternative X performance; q: indifference threshold; p: preference threshold.
c) Alternative A is strictly preferred to alternative B if the difference between the alternative performances is greater than the threshold preference. The notation is strictly preferential A **P** B.
   A P B if; and only if; $z(A) - z(B) \geq p$ (3)

where, z(X): alternative X performance; p: preference threshold.

1.2.2 Concordance index

The concordance index (Eqs. (4) and (5)) indicates the truth of the statement "alternative A outperforms alternative B" (A S B). C = 1 indicates the full truth of the assertion and C = 0 indicates that the statement is false. The graphic representation is given in Fig. 2.

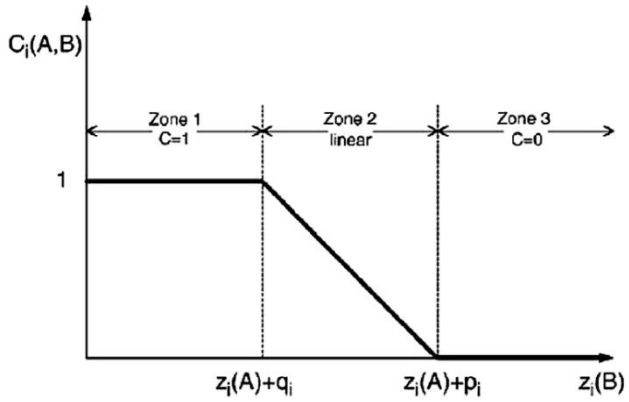

Fig.2 - Concordance index between A and B alternatives

Zone 1.$Z_i(B) - Z_i(A) \leq q_i$, alternatives A and B are indifferent, which means agreementon the statement "The alternative Aovercomes alternative B".Zone 2. $q_i < z_i(B) - z_i(A) < p_i$, the alternative B is weakly preferred to A, which means a partial agreement on the statement "The alternative A overcomes the alternative B". Zone 3.$Z_i(B) - Z_i(A) \geq p_i$, alternative B is strictly preferred to A, which means a false agreement on the statement "alternative A overcomes alternative B".

$$C(a,b) = \frac{1}{k} . \sum_{j=1}^{n} kj \, . \, cj(a,b) \quad (4)$$

Being for each criterion,

$$c_j(a,b) = \begin{cases} 1 \text{ if } g_j(a) + q_j(b) \geq g_j(b) \\ 0 \text{ if } g_j(a) + p_j(b) \leq g_j(b) \\ \underline{p_j + g_j(a) - g_j(b)}, \text{ in all cases} \\ \quad p_j - q_j \end{cases} \quad (5)$$

where, C(a,b): concordance index of actions a and b; K: sum of all weights of criteria; k_j: weight of criterion j, for j = 1, 2, 3, …, *n*; c_j: concordance index of actions a and b, under the criterion j.

1.2.3 Discordance index

If the difference in performances between alternatives A and B in a criterion i is greater than the veto threshold v_i it is cautious to refuse the statement "alternative A overcomes alternative B".The discordance index for each criterion i is given by Eq. (6). Fig 3 shows the graphic representation of this index.

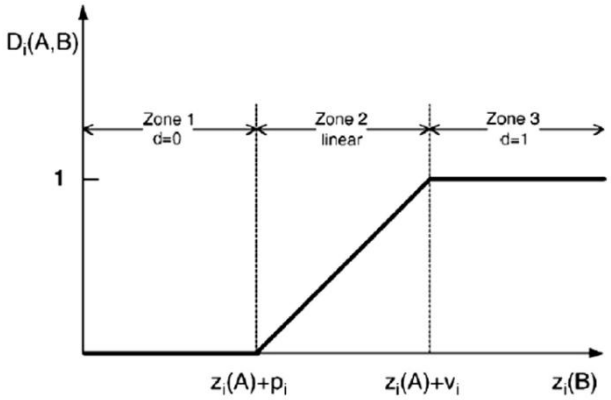

Fig.3 - Disagreement index between A and B alternatives

Zone 1.$Z_i(B) - Z_i(A) \leq p_i$, alternative B is weakly preferable to alternative A, which means no disagreement about the statement "alternative A overcomes alternative B". Zone 2. $P_i<z_i(B) - z_i(A) < v_i$, alternative B is strictly preferred to alternative A, which means weak disagreement on the assertion "alternative A overcomes alternative B". Zone 3.$Z_i(B) - Z_i(A) \geq v_i$, the difference between alternative A and alternative B exceeds the threshold for veto, which means total disagreement with the statement "alternative A overcomes alternative B".

$$d_j(a,b) = \begin{cases} 1 \text{ se } g_j(a) + v_j \leq g_j(b) \\ 0 \text{ se } g_j(a) + p_j \geq g_j(b) \\ \underline{g_j(b) - g_j(a) - p_j} \text{ nos demais casos} \\ v_j - p_j \end{cases} \quad (6)$$

where: $z_i(X)$: alternative X performance in criterion i; p_i: threshold of alternative preference on the criterion i.

1.2.4 Credibility index

Considering the concordance (Eq. (4)) and discordance (Eq. (6)) indexes, the credibility degree (Eq. (7)) indicates whether the outranking hypothesis is true or not. If the concordance index (Eq.(4)) is greater than or equal to the discordance index on all criteria (Eq. (6)), then Eq. (7) is equal to Eq. (4). If Eq. (4) is strictly below Eq. (6) then the reliability degree (Eq. (7)) is equal to Eq. (4). Note the importance of the direct relationship of these indices.

$$S(a,b) = \begin{cases} C(a,b), \text{ se } d_j(a,b) \leq C(a,b)\ \forall_j \\ C(a,b). \prod_{j \in J(a,b)} \frac{1 - dj(a,b)}{1 - C(a,b)}, otherwise \end{cases} \quad (7)$$

Where: J(A,B): is the set of criteria for di(A,B) > C(A,B).

IV. Results

1.3 Performance Matrix

In order to determine the sequence of alternatives using the processes assigned to the ELECTRE III, the performance matrix (Tables 2, 3 and 4) of alternatives for each criterion can be observed taking into account the evolution over nine years. For each criterion in Tables 2, 3 and 4, thresholds and weights were assigned by experts through questionnaires and interviews conducted directly. Tables 5 and 6 show the values for each threshold (preference, indifference and veto). In the case of weights, all these criteria at this first time, receive the same importance in the analysis, i.e., equal weights were assigned to all of them (kj ¼ 1). After calculating the indices of concordance and disagreement, the degrees of credibility are built and consolidated in the Matrix of Credibility, Tables 7 and 8. The degrees of credibility and indexed to each pair of alternatives do not produce a symmetric matrix. The next step is to explore this matrix. See Section 4.2.

Table2 - Performance Matrix - 2005 – 2007

Criteria	Alternatives														
	2005					2006					2007				
	E1	E2	E3	E4	E5	E1	E2	E3	E4	E5	E1	E2	E3	E4	E5
Economic															
EC1	2,217	4,014	3,850	4,100	2,500	1,892	3,926	1,440	4,200	2,670	2,300	3,818	1,520	4,200	2,619
EC8	5,000	4,000	3,000	5,000	3,000	5,000	4,000	2,000	5,000	3,000	5,000	4,000	3,000	5,000	3,000
Environmental															
EN3	644,599	894,000	401,000	1.004,343	985,205	811,777	718,777	985,731	1.014.351,000	973,696	660,418	739,109	955,443	101,109	1.013,187
EN8	195,871	325,573	454,012	76,846	304,658	258,913	238,662	1.065,449	201,566	317,069	257,880	215,274	1.034,607	210,698	300,230
EN16	57,217	49,962	74,720	92,215	65,425	72,200	41,382	186,454	94,912	63,516	59,547	45,566	165,826	91,977	67,055
EN50	3,868	9,487	5,693	14,166	16,219	0,825	7,048	11,796	7,175	0,636	0,429	7,678	9,012	5,871	0,837
EN20	187,432	84,635	229,852	167,056	130,411	189,696	73,971	563,166	153,947	121,082	179,750	71,041	474,045	136,986	96,241
EN60	275,684	148,794	130,938	106,916	133,699	338,122	136,777	342,466	105,023	141,604	265,396	146,387	308,219	97,847	151,684
EN21	184,131	88,906	331,614	334,113	241,096	236,468	119,331	1.054,033	161,122	477,143	205,837	115,581	937,275	133,725	314,875
EN22	657,435	161,763	315,958	198,463	283,836	456,564	188,417	300,609	160,470	227,797	352,591	121,989	484,859	109,589	206,081
EN23	332,425	300,319	180,751	200,468	282,740	424,281	244,245	1.198,630	192,433	343,748	459,797	717,581	1.207,642	164,384	347,304
EN30	1.005.783,746	3.822.238,603	9.037.537,805	2.205.145,339	3.791.780,822	924.192,864	1.744.603,940	5.098.934,551	2.092.628,832	892.719,717	1.330.107,038	787.186,865	5.046.863,735	2.478.799,739	1.464.534,723
Socials															
LA1	53.933,000	96.200,000	89.860,000	84.000,000	53.440,000	62.266,000	97.000,000	90.000,000	82.000,000	55.822,000	68.931,000	97.600,000	90.200,000	81.000,000	59.000,000
LA7	0,278	0,010	0,033	0,036	0,112	0,145	-	0,411	0,037	0,215	0,218	0,031	0,333	0,099	0,288
LA70	0,970	0,110	0,900	0,390	0,510	0,770	0,480	1,800	0,370	0,340	0,760	0,480	1,500	0,320	0,350

Table3 - Performance Matrix - 2008 - 2010

Criteria	Alternatives														
	2008					2009					2010				
	E1	E2	E3	E4	E5	E1	E2	E3	E4	E5	E1	E2	E3	E4	E5
Economic															
EC1	2,400	3,838	1,580	3,900	2,590	1,791	3,998	1,590	3,900	2,630	2,120	3,000	1,996	4,060	2,602
EC8	5,000	4,000	2,000	5,000	2,000	5,000	4,000	2,000	5,000	2,000	5,000	3,000	2,000	5,000	2,000
Environmental															
EN3	612,564	749,534	946,072	976,466	1.019,728	806,494	712,685	943,913	1.032,666	1.006,302	707,170	700,847	846,502	825,787	999,624
EN8	222,808	242,706	388,417	211,451	284,551	269,230	239,846	341,173	209,343	277,098	240,940	202,412	656,732	181,787	296,721
EN16	65,605	438,299	130,050	92,027	43,582	94,888	44,543	115,448	89,919	41,981	69,892	133,950	134,499	92,210	56,312
EN50	0,788	6,567	136,986	13,347	66,175	1,239	6,579	9,994	12,785	0,938	1,430	5,472	34,696	10.669,000	16,961
EN20	161,861	49,969	303,451	133,474	132,226	207,109	47,969	242,957	112,399	147,924	185,169	65,517	362,694	140,772	125,577
EN60	279,863	128,492	260,101	105,374	126,677	339,659	123,349	244,680	91,324	127,090	299,745	136,760	257,281	101,297	136,151
EN21	206,781	53,538	312,121	139,094	204,157	301,661	41,116	291,204	132,771	310,433	226,975	73,684	585,249	180,165	309,541
EN22	266,467	356,921	291,313	271,163	165,018	816,870	445,428	3.620,229	573,235	176,051	509,985	204,904	1.002,594	262,584	211,757
EN23	497,717	242,706	353,737	148,226	135,227	388,549	82,233	258,465	169,301	232,304	420,554	327,417	638,845	171,962	304,265
EN30	966.896,447	2.141.526,337	5.548.812,207	3.652.968,037	1.586.713,915	1.728.697,196	1.701.535,699	4.480.055,139	3.582.718,651	2.083.441,846	1.191.135,458	2.039.418,289	5.842.440,687	2.802.452,120	1.963.838,205
Socials															
LA1	74.240,000	92.000,000	90.390,000	80.000,000	60.000,000	76.919,000	80.300,000	90.000,000	81.000,000	59.800,000	67.257,800	92.620,000	90.090,000	816.000,000	57.624,400
LA7	0,242	0,022	0,022	-	-	0,091	-	0,011	0,049	-	0,195	0,013	0,162	0,044	0,123
LA70	0,592	0,430	0,600	0,360	0,360	0,480	0,340	0,400	0,300	0,270	0,714	0,368	1,040	0,348	0,366

Table4 - Performance Matrix - 2011 - 2013

Criteria	Alternatives														
	2011					2012					2013				
	E1	E2	E3	E4	E5	E1	E2	E3	E4	E5	E1	E2	E3	E4	E5
Economic															
EC1	1,956	3,499	1,793	3,980	2,616	2,136	3,565	1,897	3,555	2,789	2,257	3,456	1,901	3,495	2,888
EC8	5,000	3,000	2,000	5,000	2,000	5,000	3,000	3,000	3,000	1,000	5,000	3,000	3,000	3,000	4,000
Environmental															
EN3	756,832	706,766	895,208	929,227	1.002,963	658,696	707,569	898,569	989,633	999,365	658,666	701,256	858,252	871,252	896,652
EN8	255,085	221,766	498,953	195,662	286,909	263,058	221,565	426,365	156,325	298,256	255,787	215,236	426,333	154,210	298,222
EN16	82,390	89,247	124,973	91,065	49,147	80,369	90,336	125,365	256,256	48,265	81,525	91,256	124,252	255,222	49,352
EN50	1,334	6,025	22,345	11,727	8,949	1,666	5,999	18,256	10,256	7,598	1,887	5,878	17,266	9,897	7,984
EN20	196,139	56,743	302,825	126,586	136,751	185,236	56,222	256,326	125,365	135,265	138,569	55,421	256,333	121,356	134,569
EN60	319,702	130,055	250,980	96,311	131,620	369,789	131,056	245,362	98,365	131,333	355,244	138,256	246,365	90,252	132,254
EN21	264,318	57,400	438,226	156,464	309,987	256,333	58,400	422,365	154,253	380,236	254,211	56,421	423,635	148,222	381,325
EN22	663,428	325,166	2.311,411	417,909	193,904	701,553	325,166	1.896,325	148,257	199,256	702,444	324,151	1.752,236	138,254	197,365
EN23	404,551	204,825	449,155	172,132	268,284	431,565	205,898	458,256	444,258	258,265	399,568	201,525	455,233	321,582	259,635
EN30	1.459.916,327	1.870.476,994	5.161.247,913	3.192.585,385	2.023.640,025	1.589.999,898	1.984.253,231	3.254.125,362	3.895.365,254	1.999.854,213	1.600.002,210	1.825.632,012	3.000.252,256	2.999.654,215	2.000.125,210
Socials															
LA1	72.088,400	86.460,000	90.045,000	81.300,000	58.712,200	71.888,000	89.000,000	85.265,023	80.456,000	58.666,136	71.979,000	85.000,000	84.522,000	79.654,000	57.695,000
LA7	0,143	0,006	0,087	0,047	0,062	0,144	0,056	0,098	0,048	0,005	0,148	0,058	0,101	0,065	0,010
LA70	0,597	0,354	0,720	0,324	0,318	0,456	0,663	0,895	0,289	0,698	0,510	0,701	0,390	0,125	0,879

Table5 - Thresholds - 2005 - 2009

Criteria	Thresholds														
	2005			2006			2007			2008			2009		
	q	*p*	*v*	*q*	*p*	*v*	*q*	*p*	*v*	*q*	*p*	*v*	*q*	*p*	*v*
Economic															
EC1	0,181	0,361	0,433	0,243	0,486	0,584	0,183	0,367	0,440	0,199	0,398	0,478	0,227	0,454	0,091
EC8	0,200	0,400	0,480	0,261	0,522	0,626	0,200	0,400	0,480	0,303	0,607	0,728	0,303	0,607	0,121
Environmental															
EN3	51,672	103,344	124,012	25,783	38,675	61,880	72,451	98,234	175,882	34,628	69,256	83,107	27,324	54,647	65,577
EN8	28,451	56,901	68,281	73,053	109,580	175,328	70,906	143,959	170,175	14,365	28,729	34,475	9,833	19,667	23,600
EN16	3,286	6,572	11,830	11,267	16,901	40,562	9,540	20,807	34,344	32,442	64,883	116,790	6,515	13,030	23,453
EN50	1,060	2,120	2,544	0,951	1,426	2,281	0,787	1,738	1,889	11,551	23,103	27,723	1,050	2,099	2,519
EN20	11,062	22,124	26,549	39,262	58,893	94,230	32,638	71,901	78,332	18,464	36,928	44,313	15,400	30,801	36,961
EN60	13,364	26,728	32,073	23,448	35,173	56,276	17,733	41,182	42,560	16,569	33,139	39,766	20,835	41,670	50,004
EN21	20,766	41,531	49,837	77,190	115,785	185,256	68,432	145,622	164,237	19,072	38,144	45,772	24,376	48,753	58,503
EN22	39,362	78,724	141,703	23,691	35,536	85,286	32,185	55,876	115,867	13,800	27,600	49,680	282,628	565,256	1.017,462
EN23	13,119	26,238	31,485	82,242	123,363	197,380	80,882	163,124	194,118	26,051	52,102	62,522	22,671	45,343	54,411
EN30	306.736,017	613.472,034	1.840.416,103	172.823,663	345.647,325	1.036.941,976	169.364,366	338.728,732	1.016.186,197	184.033,401	368.066,803	1.104.200,408	125.171,120	250.342,240	751.026,719
Socials															
LA1	4.072,748	8.145,496	9.774,596	3.544,204	7.088,407	8.506,089	3.124,397	6.668,600	7.498,552	2.613,156	5.226,312	6.271,574	2.213,399	4.426,799	5.312,159
LA7	0,022	0,044	0,053	0,033	0,065	0,089	0,025	0,058	0,061	0,021	0,042	0,050	0,008	0,016	0,019
LA70	0,072	0,144	0,172	0,122	0,244	0,293	0,098	0,220	0,235	0,024	0,048	0,057	0,017	0,034	0,040

Table6 - Thresholds - 2010 - 2013

Criteria	Thresholds											
	2010			2011			2012			2013		
	q	*p*	*v*	*q*	*p*	*v*	*q*	*p*	*v*	*q*	*p*	*v*
Economic												
EC1	0,207	0,413	0,405	0,207	0,413	0,284	0,211	0,425	0,202	0,201	0,398	0,256
EC8	0,253	0,507	0,487	0,253	0,507	0,425	0,264	0,528	0,415	0,152	0,325	0,189
Environmental												
EN3	42,372	72,831	102,092	42,372	72,831	74,342	34,628	98,234	124,012	51,672	69,256	175,882
EN8	39,322	71,767	94,372	39,322	71,767	29,038	14,365	143,959	68,281	28,451	28,729	170,175
EN16	12,610	24,439	45,396	12,610	24,439	70,122	32,442	20,807	11,830	3,286	64,883	34,344
EN50	3,080	6,097	7,391	3,080	6,097	15,121	11,551	1,738	2,544	1,060	23,103	1,889
EN20	23,365	44,129	56,077	23,365	44,129	40,637	18,464	71,901	26,549	11,062	36,928	78,332
EN60	18,390	35,578	44,136	18,390	35,578	44,885	16,569	41,182	32,073	13,364	33,139	42,560
EN21	41,967	77,967	100,721	41,967	77,967	52,138	19,072	145,622	49,837	20,766	38,144	164,237
EN22	78,333	152,598	282,000	78,333	152,598	533,571	13,800	55,876	141,703	39,362	27,600	115,867
EN23	44,993	82,034	107,983	44,993	82,034	58,467	26,051	163,124	31,485	13,119	52,102	194,118
EN30	191.625,713	383.251,427	1.149.754,281	191.625,713	383.251,427	927.613,563	184.033,401	338.728,732	1.840.416,103	306.736,017	368.066,803	1.016.186,197
Socials												
LA1	3.113,581	6.311,123	7.472,594	3.113,581	6.311,123	5.791,866	2.613,156	6.668,600	9.774,596	4.072,748	5.226,312	7.498,552
LA7	0,022	0,045	0,054	0,022	0,045	0,034	0,021	0,058	0,053	0,022	0,042	0,061
LA70	0,066	0,138	0,160	0,066	0,138	0,049	0,024	0,220	0,172	0,072	0,048	0,235

1.4 Distillation

A graph can be drawn from the credibility matrix (Tables 7 and 8). Each alternative is connected with another one by two arrows, one in each direction indicating the credibility index. The graph for many alternatives is highly complex. An automated procedure named distillation, should be used to rank the alternatives. The name "distillation" was chosen by analogy to alchemists who distill mixtures of liquid to extract a magic ingredient. The algorithm to classify all alternatives can be divided into two pre-classifications. The first pre-classification is achieved with descending distillation by selecting the best ranked alternatives initially and ending with the worst. The best alternative is extracted from the whole set by applying very strict rules (Eq. (8)). In this subset, the best alternatives are selected by application of less restrictive rules (Eq.(10)), and the same rules previously used would bring a different result. The procedure continues with less restrictive rules and a lower number of alternatives (subsets). The procedure ends when it remains only one alternative or a group of alternatives that cannot be separated. The second distillation uses the same procedure, but in the original set of alternatives removed, at first, the best results from the distillation. Thus, a new subset is obtained in each distillation, which contains the best alternative. In each distillation, the alternative extracted will be ranked at an inferior position. As an alternative is connected with each other by two arrows, one in each direction, but not necessarily with symmetrical credibility index; a second pre-classification is constructed with ascendant distillation. In this case, the worst alternatives are first selected and the distillation ends with the assign of the best alternative. For distillation, it is necessary that an alternative a preferred to b is defined as follows: the alternative a preferred to b if the degree of credibility that "A exceeds B" is superior to the threshold λ_2 and significantly higher than the degree credibility "B exceeds A" (Eq. (8)).

$S(A; B) > \lambda_2$ and $S(A; B) - S(B; A) > s(\lambda_0)$ (8)

Where λ_2 is the highest level of credibility, which is slightly below the cutoff λ_1, as follows:

$\lambda_2 = Max_{\{S(A,B)\leq\lambda 1\}} S(A,B) \forall \{A,B\} \in G$ (9)

Where G is the set of alternatives.λ_1 is the next level:

$\lambda_1 = \lambda_0 - s(\lambda_0)$ (10)

where λ_0 is the greatest degree of credibility in the respective credibility matrix:
$\lambda_0 = Max_{A,B \in G} S(A,B)$(11)
and $s(\lambda_0)$ is the following threshold discrimination:
$s(\lambda_0) = \alpha + \beta \, . \, \lambda_0$(12)
It is used a $\alpha = 0.3$ and b $\beta = -0.15$ since both values are recommended by Roy (1985).

Table7 - Credibility Matrix - 2005 - 2009

2005	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,80	-	0,00	0,00	0,93
E3	0,00	0,00	-	0,00	0,00
E4	0,00	0,00	0,00	-	0,00
E5	0,75	0,00	0,00	0,00	-

2006	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,93	-	0,00	0,91	0,85
E3	0,00	0,00	-	0,00	0,00
E4	0,84	0,00	0,00	-	0,47
E5	0,00	0,00	0,00	0,00	-

2007	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,00	-	0,00	0,00	0,00
E3	0,00	0,00	-	0,00	0,00
E4	0,87	0,74	0,00	-	0,86
E5	0,00	0,00	0,00	0,00	-

2008	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,00	-	0,00	0,00	0,00
E3	0,00	0,00	-	0,00	0,00
E4	0,88	0,00	0,93	-	0,87
E5	0,00	0,00	0,00	0,00	-

2009	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,88	-	0,00	0,00	0,79
E3	0,00	0,00	-	0,00	0,00
E4	0,87	0,00	0,83	-	0,73
E5	0,00	0,00	0,00	0,00	-

Table8 - Credibility Matrix - 2010 - 2013

2010	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,86	-	0,00	0,00	0,59
E3	0,00	0,00	-	0,00	0,00
E4	0,86	0,00	0,00	-	0,00
E5	0,76	0,00	0,00	0,00	-

2011	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,93	-	0,00	0,00	0,80
E3	0,00	0,00	-	0,00	0,00
E4	0,90	0,00	0,00	-	0,00
E5	0,81	0,00	0,00	0,00	-

2012	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,58	-	0,00	0,00	0,69
E3	0,00	0,00	-	0,00	0,70
E4	0,99	0,00	0,00	-	0,00
E5	0,78	0,00	0,00	0,00	-

2013	E1	E2	E3	E4	E5
E1	-	0,00	0,00	0,00	0,00
E2	0,46	-	0,00	0,00	0,00
E3	0,00	0,00	-	0,00	0,63
E4	0,71	0,00	0,56	-	0,00
E5	0,66	0,00	0,00	0,00	-

By applying this procedure for all from 2005 to 2013, there are the distillations shown in Figs. 4 and 5. It may be noted that the result of descendant distillation in 2006 was similar to that in 2005, the company E2 had preference over the others followed by the company E4. The others did not receive preferences related, resulting in indifference between them.

In the years 2007 and 2008, results of descendant distillation were similar; the company E4 had preference over the others. Indifference, in these two years, was among four other companies, highlighting the strong preference for the company E4.

The result of descendant distillation showed preference for the company E4, followed by the company E2 in 2009. Regarding the companies E1, E3 and E5, there was no preference between them. Finally, in 2010 and 2011 the resultwas similar, and the company E2 had preference over the others followed by the company E4 (Fig. 4).

The ascendant distillation showed that the company E1 got preference over the others, followed by companies E4 and E5 in 2006. The others did not receive preferences related, resulting in indifference between them.

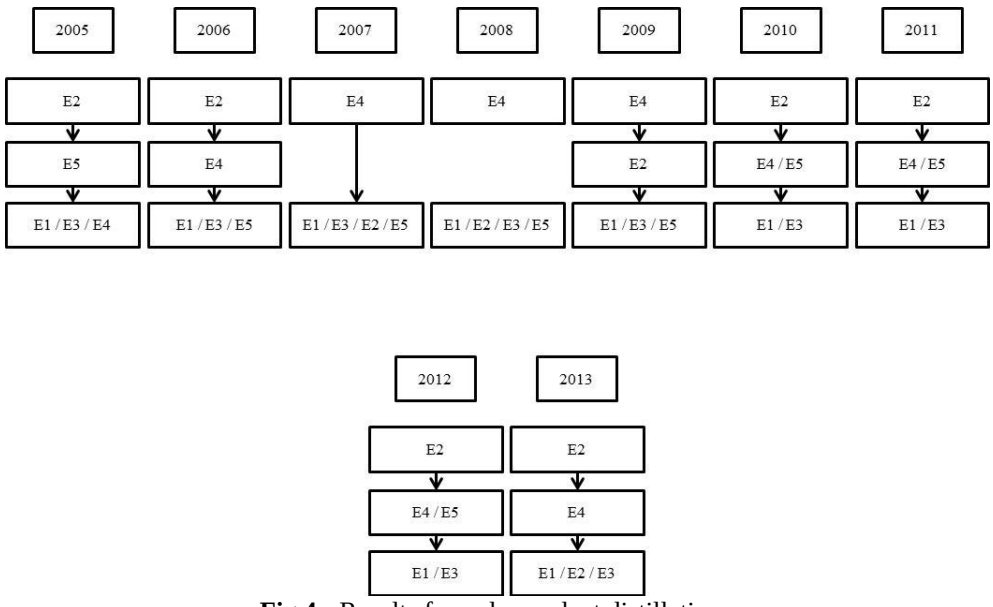

Fig.4 - Results from descendent distillations

In the years 2007 and 2008, the results of ascendant distillation were similar. For the former, companies E1, E2 and E5 were ranked as the best and the companies at the second best position were E1, E3 and E5. It is noticed that only the E2 company is not indifferent to the other in the second year analyzed. For other companies, there was no preference between them. In 2009, the result of ascendant distillation showed preference for companies E1 and E5, followed by the company E3. Regarding the companies E2 and E5, there was no preference between them.

Finally, in 2010 and 2011 the result was similar, and the company E2 had preference over the others followed by the companies E4 and E5 (Fig. 5). In 2012 and 2013 the result was similar to 2010.

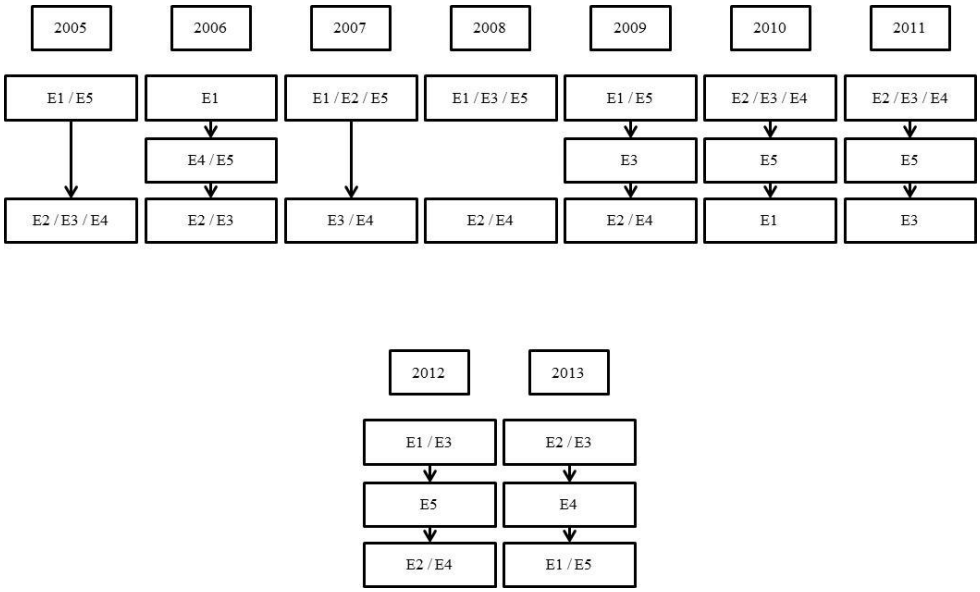

Fig.5 - Results from ascendent distillations

With successive distillations, the cutoff level λ_1 is gradually reduced, which makes it much easier to be preferred to B. However it contains some arbitrariness such as the recommended values of α and β (Takeda, 2001). Other values may be used, which can slightly change the classification.

1.5 Final Ordination

The final ordination (Fig. 6) is obtained by combining two preclassifications. Refer to Section 4.2. Partial results of preclassifications are aggregated in the classification matrix. There are four possible cases (Xu and Ouenniche, 2012):

i. The alternative A is better than B or in both distillations or A is better than B in one distillation and it has the same position in the other one, subsequently A is better than B: **A P^+B**;
ii. The alternative A is greater than B in one distillation, but B is better than A in another distillation, then A is incomparable to B: **A R B**;
iii. Alternative A has the same position that B in both distillations, therefore A is indifferent to B: **A I B**;
iv. A is smaller than B in both distillations or A is smaller than B in one distillation and it has the same rank in the other distillation, then A is worse than B: A **P^- B**.

The company E4 had the best performance, considering its evolution. This companywas indifferent to E3 (E4I E3) and the incomparable company E5 (E4 R E5) in 2005 and 2006, and it obtained the second position in the ordination; however, in the following years its performance was considered more relevant, enabling a prominent position before the others;

The company E2 obtained the second best performance, considering its evolution. The company ranked first in the ranking in 2005 and 2006, only falling to second position in the other years, except 2010 and 2011, where E2 was first too. This favorable performance in seven years provided its effective implementation and criteria analyzed;

The company E3 has remained virtually constant in all years. In the years 2005 to 2007 it took the second position in the ranking, dropping to third in the years 2008 and 2009, which earned him third place overall. This company was considered indifferent to enterprises E1 and E5 (E1 I E3) and (E3 I E5) in 2008, which did not happen again in 2009.

In 2010 and 2011, the company E2 had the best performance, considering this evolution. Not the same was considered in 2012 and 2013, where this company was the second.

The company E5 began at second position in the ordination in 2005, just indifferent to companies E2 and E4 (E4 I E5) and (E5 I E2). In the years 2006e2008 it remained at the third position, being indifferent to the companies E1 (E1 I E5), E2 (E5 I E2) and E3 (E3 I E5). In 2009 it got the last position, being indifferent to the company E1 only. In 2010 and 2011, this company had the third best performance, being indifferent by E3. This low performance improvement for company E5 allowed its fourth position overall in the final ordination. This similar result could be analyzed in 2012 and 2013.

The company E1 got the worse evolution according to the criteria analyzed. This got the last position every year, being indifferent to companies E2 (E1 I E2) and E5 (E5 I E1) in 2007,E3 (E1 I E3) and E5 (E5 I E1) in 2008, only the company E5 (E1 I E5) in 2009, and in 2010 to 2013 this companywas the worst.

In order to analyze the robustness of results, the sensitivity analysis was performed, whose weighted values, thresholds and criteria arrangements were varied.

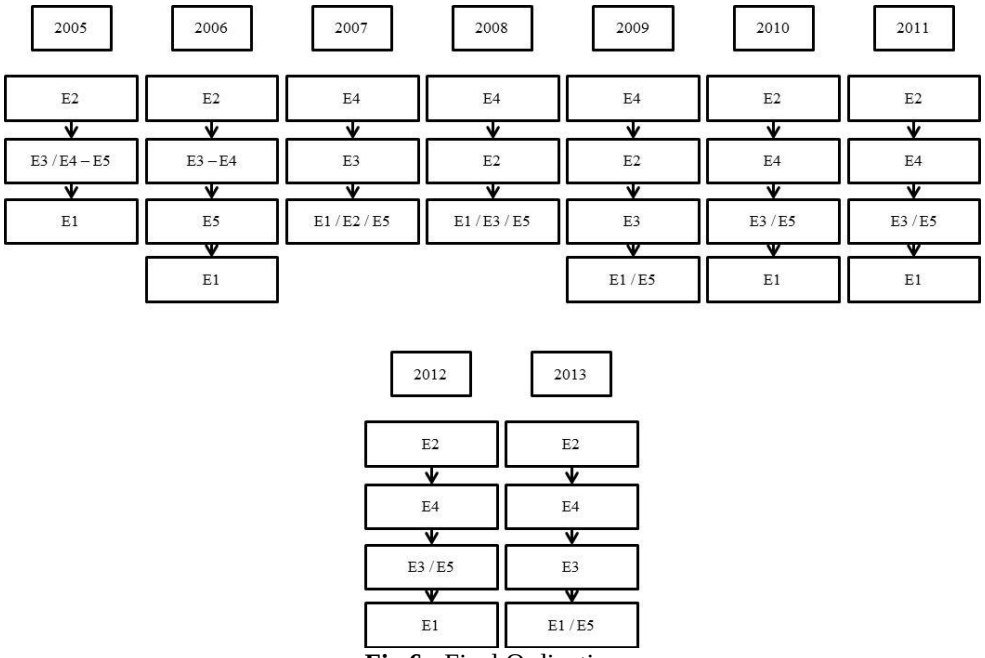

Fig.6 - Final Ordination

1.5.1 Sensitivity analysis

A sensitivity analysis (Tables 9 and 10) was carried out varying the weights and some criteria arrangements. This analysis was performed to obtain a greater robustness of the results. At the stage of new criteria, arrangements resulted in nine important combinations in order to verify the accuracy of the final ordination. The change in weights of the criteria groups, i.e. economic, social and environmental groups was performed by assigning weights between 1.5 and 2.5 to each group, resulting in six combinations. It is important to remember that the weights of all criteria were equal originally. A total of fifteen new combinations were performed to assess the final ordination's robustness, Fig. 6. Tables 9 and 10 show the sensitivity analysis for the years 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012 and 2013. Checking for the sensitivity analyzes performed for each year surveyed (Tables 9 and 10), there is consistency in the results, which according to the final ordination has prevailed (Fig. 6). In 2005 the disparity in the new ordination after changes performed is negligible, as it can be seen in other years. The weights assigned confirmed that, even with the change in importance of the criteria groups, there is a big change in the ordination of companies, which features robustness to the final result.

Table9 - SensibilityAnalysis - 2005 - 2009

2005			2006			2007			2008			2009		
	Sensibility	Ranking		Sensibility	Ranking		Sensibility	Ranking		Sensibility	Ranking		Sensibility	Ranking
1	-(EN3)	E2 - (E3;E4)(E5)-E1	1	-(EN3)	E2-[E3][E4]-E5-E1	1	-(EN3)	E4-E3-E2-(E1;E5)	1	-(EN3)	E4-E2-(E1;E3;E5)	1	-(EN3)	(E2;E4)-E3-E5-E1
2	-(EN3; EN16)	E2 - (E3;E4)(E5)-E1	2	-(EN3; EN16)	E2-[E3][E4]-E5-E1	2	-(EN3; EN16)	E4-E3-(E1;E2;E5)	2	-(EN3; EN16)	E4-E2-E3-(E1;E5)	2	-(EN3; EN16)	E4-E2-E3-E5-E1
3	-(EN16)	E2 - (E3;E4)(E5)-E1	3	-(EN16)	E2-[E3][E4]-E5-E1	3	-(EN16)	E4-E3-(E1;E2;E5)	3	-(EN16)	E4-E2-E3-(E1;E5)	3	-(EN16)	E4-E2-E3-(E1;E5)
4	-(EN21)	E2-E4-[E3][E5]-E1	4	-(EN21)	E2-[E3][E4]-(E5)-E1	4	-(EN21)	E4-E3-E2-(E1;E5)	4	-(EN21)	E4-E2-(E1;E3;E5)	4	-(EN21)	E4-E2-E3-(E1;E5)
5	-(EN21; EN22)	E2-E4-[E3][E5]-E2	5	-(EN21; EN22)	E2-[E3][E4]-(E5)-E1	5	-(EN21; EN22)	E4-E3-E2-(E1;E5)	5	-(EN21; EN22)	E4-E2-(E1;E3;E5)	5	-(EN21; EN22)	E4-E2-E3-(E1;E5)
6	-(EN22)	E2-(E3;E4)[E5]-E1	6	-(EN22)	E2-[E3][E4]-E5-E1	6	-(EN22)	E4-E3-E2-(E1;E5)	6	-(EN22)	E4-E2-(E1;E3;E5)	6	-(EN22)	E4-E2-E3-(E1;E5)
7	-(EN23)	E2-(E3;E4)[E5]-E2	7	-(EN23)	E2-[E3][E4]-E5-E1	7	-(EN23)	E4-E3-E2-(E1;E5)	7	-(EN23)	E4-E2-(E1;E3;E5)	7	-(EN23)	E4-E2-E3-(E1;E5)
8	-(EN30)	E2-(E3;E4)[E5]-E3	8	-(EN30)	E2-[E3][E4]-E5-E1	8	-(EN30)	E4-E2-[E1][E5]-E3	8	-(EN30)	E4-[E1][E2]-E5-E3	8	-(EN30)	E2-E4-[E1][E5]-E3
9	-(LA7)	E2-(E3;E4)[E5]-E4	9	-(LA7)	E2-[E3][E4]-E5-E1	9	-(LA7)	E4-E3-(E1;E2;E5)	9	-(LA7)	E4-E2-(E1;E3;E5)	9	-(LA7)	E4-E2-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**			**Weights**	
10	Economics - 2 Environmental - 2,5 Socials - 1,5	E2-(E3;E4)[E5]-E4	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E2-[E3][E4]-E5-E1	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E4-E3-(E1;E2;E5)	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E4-E2-(E1;E3;E5)	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E4-E2-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**			**Weights**	
11	Economics - 2 Environmental - 1,5 Socials - 2,5	E2-(E3;E4)[E5]-E4	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E2-[E3][E4]-E5-E1	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E4-E3-E2-(E1;E5)	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E4-E2-(E1;E3;E5)	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E4-E2-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**			**Weights**	
12	Economics - 2,5 Environmental - 2 Socials - 1,5	E2-(E3;E4)[E5]-E4	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E2-[E3][E4]-E5-E1	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E4-E3-(E1;E2;E5)	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E4-E2-(E1;E3;E5)	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E4-E2-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**			**Weights**	
13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E2-(E3;E4)[E5]-E4	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E2-[E3][E4]-E5-E1	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E4-E3-(E1;E2;E5)	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E4-E2-(E1;E3;E5)	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E4-E2-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**			**Weights**	
14	Economics - 1,5 Environmental - 2,5 Socials - 2	E2-(E3;E4)[E5]-E4	14	Economics - 1,5 Environmental - 2,5 Socials - 2	E2-[E3][E4]-E5-E1	14	Economics - 1,5 Environmental - 2,5 Socials - 2	E4-E3-(E1;E2;E5)	14	Economics - 1,5 Environmental - 2,5 Socials - 2	E4-E2-(E1;E3;E5)	14	Economics - 1,5 Environmental - 2,5 Socials - 2	(E2;E4)-E3-E5-E1
	Weights			**Weights**			**Weights**			**Weights**			**Weights**	
15	Economics - 1,5 Environmental - 2 Socials - 2,5	E2-(E3;E4)[E5]-E4	15	Economics - 1,5 Environmental - 2 Socials - 2,5	E2-[E3][E4]-E5-E1	15	Economics - 1,5 Environmental - 2 Socials - 2,5	E4-E3-E2-(E1;E5)	15	Economics - 1,5 Environmental - 2 Socials - 2,5	E4-E2-(E1;E3;E5)	15	Economics - 1,5 Environmental - 2 Socials - 2,5	(E2;E4)-E3-E5-E1

Table10 - SensibilityAnalysis - 2010 - 2013

2010			2011			2012			2013		
	Sensibility	Ranking		Sensibility	Ranking		Sensibility	Ranking		Sensibility	Ranking
1	-(EN3)	E2-E4-[E3][E5];E1	1	-(EN3)	E2-E4-[E3][E5];E1	1	-(EN3)	E2-E4-[E3][E5];E1	1	-(EN3)	E2-E4-E3-(E1;E5)
2	-(EN3; EN16)	E2-E4-[E3][E5];E1	2	-(EN3; EN16)	E2-E4-[E3][E5];E1	2	-(EN3; EN16)	E2-E4-[E3][E5];E1	2	-(EN3; EN16)	E2-E4-E3-(E1;E5)
3	-(EN16)	E2-E4-[E3][E5];E1	3	-(EN16)	E2-E4-[E3][E5];E1	3	-(EN16)	E2-E4-[E3][E5];E1	3	-(EN16)	E2-E4-E3-(E1;E5)
4	-(EN21)	E2-E4-[E3][E5];E1	4	-(EN21)	E2-E4-[E3][E5];E1	4	-(EN21)	E2-E4-[E3][E5];E1	4	-(EN21)	E2-E4-E3-(E1;E5)
5	-(EN21; EN22)	E2-E4-[E3][E5];E1	5	-(EN21; EN22)	E2-E4-[E3][E5];E1	5	-(EN21; EN22)	E2-E4-[E3][E5];E1	5	-(EN21; EN22)	E2-E4-E3-(E1;E5)
6	-(EN22)	E2-E4-[E3][E5];E1	6	-(EN22)	E2-E4-[E3][E5];E1	6	-(EN22)	E2-E4-[E3][E5];E1	6	-(EN22)	E2-E4-E3-(E1;E5)
7	-(EN23)	E2-[E3][E5]-E4-E1	7	-(EN23)	E4-[E3][E5]-E2-E1	7	-(EN23)	E2-E4-(E3;E5);E1	7	-(EN23)	E2-E4-E3-E1-E5
8	-(EN30)	E2-E4-E5-E3-E1	8	-(EN30)	E4-E2-E5-E3-E1	8	-(EN30)	E2-E4-(E3;E5);E1	8	-(EN30)	E2-E4-E3-E1-E5
9	-(LA7)	E2-[E3][E5]-E4-E1	9	-(LA7)	E2-E4-[E3][E5];E1	9	-(LA7)	E2-E4-(E3;E5);E1	9	-(LA7)	E2-E4-E3-E1-E5
	Weights			**Weights**			**Weights**			**Weights**	
10	Economics - 2 Environmental - 2,5 Socials - 1,5	E2-[E3][E5]-E4-E1	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E4-E2-[E3][E5];E1	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E2-E4-[E3][E5];E1	10	Economics - 2 Environmental - 2,5 Socials - 1,5	E2-E4-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**	
11	Economics - 2 Environmental - 1,5 Socials - 2,5	E2-[E3][E5]-E4-E1	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E4-E2-[E3][E5];E1	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E2-E4-[E3][E5];E1	11	Economics - 2 Environmental - 1,5 Socials - 2,5	E2-E4-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**	
12	Economics - 2,5 Environmental - 2 Socials - 1,5	E2-[E3][E5]-E4-E1	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E2-E4-[E3][E5];E1	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E2-E4-[E3][E5];E1	12	Economics - 2,5 Environmental - 2 Socials - 1,5	E2-E4-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**	
13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E2-[E3][E5]-E4-E1	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E2-E4-[E3][E5];E1	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E2-E4-[E3][E5];E1	13	Economics - 2.5 Environmental - 1,5 Socials - 2,5	E2-E4-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**	
14	Economics - 1,5 Environmental - 2,5 Socials - 2	E2-[E3][E5]-E4-E1	14	Economics - 1,5 Environmental - 2,5 Socials - 2	E2-E4-[E3][E5];E1	14	Economics - 1,5 Environmental - 2,5 Socials - 2	E2-E4-[E3][E5];E1	14	Economics - 1,5 Environmental - 2,5 Socials - 2	E2-E4-E3-(E1;E5)
	Weights			**Weights**			**Weights**			**Weights**	
15	Economics - 1,5 Environmental - 2 Socials - 2,5	E2-[E3][E5]-E4-E1	15	Economics - 1,5 Environmental - 2 Socials - 2,5	E2-E4-[E3][E5];E1	15	Economics - 1,5 Environmental - 2 Socials - 2,5	E2-E4-[E3][E5];E1	15	Economics - 1,5 Environmental - 2 Socials - 2,5	E2-E4-E3-(E1;E5)

It was observed that the criterion - EN30 e Total investments and operating costs - was significant in all years analyzed, since its withdrawal from the analysis directly impacted the finalordination, resulting in indifference between enterprises E1, E2and E5. In the years 2005 and 2006 the criterion of greatestimpact was EN 21 - Total water discharge by quality and destination - whose withdrawal from the analysis partially modifiedthe final ordination, causing incomparability of the E5 companyin relation to the others and indifference between companies E3and E4.

The variation of weights in the criteria groups had a major impact only in 2009, where amendments 15 and 16 partially modified the companies' final ordination, changing the indifference to companies E2 and E4, which was previously observed in companies E1 and E5.

V. Conclusions

The system application provided the ranking of companies, which proved to be little susceptible to the variation of criteria weights, as well as in changing the arrangement of some other criteria.

The application of the method ELECTRE III promoted working on the objective (criteria values) and subjective (weights and criteria thresholds) variables in combination, characteristic that directs a hierarchy process understood as more sensitive to the complexity of decisions.

The criteria presented and discussed were adequate for evaluating the companies in the oil and gas sector, as they encompassed economic, environmental and social aspects for the study. It should be noted that, regarding the risks to the environmental criteria, there is need for a more accurate survey in the field, in order to evaluate all parameters that influence such a criterion, but for the present study, the evaluation performed was satisfactory. The study allowed analyzing the companies, strategically, checking for their development and performance in the years studied. According to the criteria selected, these companies were ordered to obtain comparisons and improvements in their production processes.

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