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"Gheorghe Asachi" Technical University of Iasi, Romania

SELECTION AND USE OF EMAS III INDICATORS AND AHP METHODOLOGY IN ANALYSIS OF ORGANIZATION ENVIRONMENTAL PERFORMANCE

Georgeta Madalina Arama*, Luoana Florentina Pascu, Carol Lehr

INCD-ECOIND Bucharest, 71-73, Drumul Podu Dambovitei District 6, 060652, Bucharest, Romania

Abstract

The paper presents a Multi-Criteria Decision Analysis (MCDA) methodology to analyze environmental performance indicators of an organization designed according to Eco-Management and Audit Scheme III - Regulation (EMAS III). The newly proposed indicators are intended to achieve Best Environmental Management Practice (BEMP) to facilitate and harmonize the way the environmental performance is reported and analyzed periodically within the Environmental Management System (EMS) of the organization. During each environmental management analysis, the state regarding the accomplishment of the proposed objectives stated in the organization environmental policy should be checked. This way, adequate and timely measures should be taken to meet the objectives and improve environmental performance. While referential documents ISO 14000 standards series and European legislation - EMAS III Regulation requirements are well explained within environmental management literature, the instruments for their implementation at organizational level need yet improvements. One such improvement endeavor is the release of BEMP sectoral documents which include new EMAS III indicators for environmental performance analysis. Instruments that should be used in order to analyze those environmental performance indicators can also be improved to help in managing the significant environmental impacts of organization and the associated environmental risk. Using results from operational research field and applying them to the environmental management can produce reliable scientifically based methodologies. General considerations about how to use the Analytical Hierarchy Process (AHP) methodology as a MCDA tool for environmental management analysis are presented.

Key words: Analytical Hierarchy Process, Environmental Management System, environmental indicators, Multi-Criteria Decision Analysis

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1. Introduction

An Environmental Management System (EMS) of an organization is developed and implemented according to either ISO 14001 (2004) or EMAS (EMAS III, 2009) standard recommendations, to help organization to manage all direct/indirect environmental impacts linked to its activities/products/services. "These reference standards propose requirements for planning and implementing an EMS to obtain continuous environmental improvement in ways that are consistent with modern management models" (Mazzi, et al., 2012). Both standards are voluntary initiatives representing: 1) EMAS Regulation - the public sector initiative and 2) ISO 14001 standard - the private sector initiative. Although they both have the same objective - promoting environmental awareness of firms/organizations in order to fulfill sustainable development - the firms' responsiveness towards the certification according to EMAS Regulation or ISO 14001 standards was different along the time (Daddi

* Author to whom all correspondence should be addressed: e-mail: madalinaarama@yahoo.com, evmt@incdecoind.ro; Phone: 04. 021. 410.03.77-261, 0724307609; Fax: 04.021.410.05.75, 04.021.412.00.42

et al., 2014). Despite the fact that EMAS Regulation appeared first on the market in 1993 and ISO 14001 standard followed it in 1996, EMAS was less preferred than ISO 14001. Literature in the field shows that a possible reason might be that EMAS is more applicable and consequently preferred by larger/more complex organizational settings (many subsidiaries, larger number of employees, more installations etc.) (Bracke et al., 2008). Such findings are endorsing the smaller number of EMAS certificates existing on the European market because its structure in 2012 shows a proportion of medium and larger companies of only 1.1% and respectively 0.2% from the total existing companies, the rest of 98.7% being represented by micro and small organizations. This preference for ISO 14001 certification might be due also to the fact that, for approximately the same type of possible market benefits obtainable through certification (tangible-subsidies, non-tangible-positive image etc.), EMAS has higher implementation/certification and maintenance costs. The higher costs are due to the fact that EMAS Regulation is more demanding than ISO 14001 standards, requiring that organizations release to the public/stakeholders more information about their activities/products/services in documents like environmental policy, criteria used to establish significant aspects/impacts, environmental performance report. The advantage for the community and for the sustainable development goals is that EMAS III Regulation promotes more transparency in verification of the fulfillment of the declared publically reported environmental performance. However, that involves higher costs in EMS certification/maintenance because thorough periodic analyses should be performed, more data should be gather and more higher education personnel should be involved. A present approach trying to mitigate the impact of higher costs was the shift towards the certification of clusters of companies aiming to increase stakeholder's involvement (Merli et al., 2014).

Taking into account all these aspects we consider that having a scientific based muticriterial methodological instrument to analyze environmental performance indicators in complex settings (big companies or clusters of companies) should be helpful in EMS implementation/maintenance. In the EMAS III vision (EMAS III, 2009) the best practices in managing organizational environmental complex issues should be promoted and should be the result of a continuous information exchange and cooperation among Member States within each specific sector of activity, but also between different sectors. The present EMAS III endeavor of adopting new indicators was the result of lessons learned from previous years EMAS implementation experience trying to improve the comparability and utility of information from organizations' statements (Antonis et al., 2013; Erkko et al., 2005; Friemann, 1997). EMAS III requires that "core indicators shall apply to all types of organizations being focused on the following key environmental areas: energy efficiency, material efficiency, water, wastes, biodiversity, pollutants emissions."

Thus, relevant performance indicators can be created and reported in a harmonized way leading to harmonization of environmental protection management. In this idea, EMAS III Regulation requires to report the environmental performance indicators using relevant quantities for the organization's dimensions and activities (e.g. annual organization gross value added, annual organization turnover, annual organization quantitative output, the average annual number of employees etc.). This way the impacts induced on the environment can be better linked to the level of its production/services and possible negative externalities induced to other organizations might be revealed (Picazo-Tadeo and Prior, 2009). An environmental aware company who wants to comply with EMAS III should start to analyze the new proposed EMAS III indicators taking appropriate measures in due time so that "economic performance might be improved while simultaneously enhancing environmental performance.

It is now recognized that competitive firms - through their innovative capacity - even there are among the biggest good output producers might be not necessarily be among the greatest polluters" (Picazo-Tadeo and Prior, 2009). In this respect, they can choose the relevant indicators for the organization in order to show its efforts for protecting the environment. EMS environmental performance indicators are defined in literature as being "measures for system behavior in terms of perceivable with sense attributes" (Petrosillo et al., 2012). However, having indicators to measure environmental aspects/impacts and to link them to the nature and dimensions of organization does not assure automatically that organization can assess them at a glance without an adequate analysis. That is precisely why, having a good and reliable method for analysis seems to be an important factor for the real/solid success of the implementation of those indicators in order to select the appropriate course of action to improve environmental performance.

The objective of the presented work was to design a new methodology based on Multi-Criteria Decision Analysis (MCDA) methodology - Analytical Hierarchy Process (AHP) to analyze environmental performance indicators of an organization designed according to Eco-Management and Audit Scheme III – Regulation (EMAS III) in order to take appropriate measures to accomplish its environmental policy objectives. A simulated case study of using performance indicators within a management analysis using a MCDA tool namely AHP is presented in next sections.

2. Method

Why we need a new methodology for analysis? This is a legitimate question that the reader may ask knowing that the literature in the field starting with late '90 until now presents a number of different methodologies for specific applications (Munda, 2005; Ying et al., 2007; Zabeo, 2011; Zheng et al., 2012). One possible answer to this question is because we have learned from reported EMS implementation experience that different types of multi-criteria methodologies proved to be best suited only for specific applications and their extension to others was less successful and recommended. As is the case with conceiving more and reliable environmental indicators highlighting sustainability - where more improvement is needed - the same is the case with methodologies to be used at the organizational level in assessing the environmental performances expressed with those indicators. From the practical point of view we should note that the EMS standards (both EMAS and ISO 14001) always recommend what to do but they leave to the organizations' choice how to do it. That is precisely why, consultancy practice in this field along the years, was very well represented, trying to feel in the gap between theory and practice.

To be more specific EMAS III introduced the new indicators with the declared intention to compare organizations' environmental performances within sectors, regions etc. In order to fulfill this desiderate, and to put the management theory into the organization practice, analytical methodologies special dedicated for group decision, that are transparent and based on relevant consensual agreed criteria should be chosen. For simple organizational structures, with lower number of employees, to take good reliable decisions is less demanding than for complex ones (organizations with larger number of employees, with many subsidiaries units and with many installations with considerable impacts on the environment). For such big organizations taking adequate measures at different moments means a case by case analysis, good comparisons between the measured indicators reflecting the status of the fulfillment of environmental organizational policy and, that is not a trivial work. Proposing this methodology, we do not want to generate more EMS unnecessary paper work (records, procedures, long reports etc. for organizational environmental management analysis) but more reliable documented environmental assessments and decisions. The proposed methodology, except from some forms to be fill in (pairwise comparison matrices) is friendly in use because most of assessments computational tasks can be automated generating short and comprehensive assessments/decision reports.

The proposed AHP method uses a set of forms with relevant questions given to a group/panel of evaluators whose processed answers linked to EMAS III relevant indicators can be used to make the desired assessments. The AHP ranking is a democratic and consensual decision instrument where all evaluators from a group/panel made of environmental responsible persons/managers from installations/organization, have the opportunity to express their own values-system based on knowledge and experience in the assessment area through the process of weighing criteria/alternatives Thus, employees/stake-holders can be involved to participate in organization environmental assessing/decision making process as EMS requires. Using AHP the assessment process becomes transparent and the consistency of assessors' judgments can be also checked. Developed by Thomas L. Saaty, it is largely used in group decision taking applications. AHP is one of the extensively used MCDA methods (Arbel and Orgler, 1990; Bargranof, 1989; Moutinho, 1993; Nouri et al., 2016) in maintenance policy selection (Arunraj and Maiti, 2010), environmental decision-making (Chiang and Lai, 2002; Obradovic et al., 2017; Patrick and Laurence, 1999), risk assessment (Gaudenzi and Borghesi, 2006; Mustafa and al-Bahar, 1991; Wang et al., 2012; Zayed et al., 2008), handling both qualitative and quantitative data (Cengiz et al., 2003; Zheng et al., 2012). "The AHP methodology is particularly convenient for comparing different investment alternatives" (Solnes, 2003).

"AHP is carried out in two phases (design and evaluation phases). The design of the hierarchy requires an evaluator's experience and knowledge of the problem area which is already accomplished in the case of people from different organization's installations that can be involved to participate in the periodical management analysis." The hierarchy is structured such that the top-most node is the overall objective. Subsequent nodes at lower levels in the hierarchy consist of the criteria used in arriving at this decision" (Heller, 2006). It "allows decision makers: (i) to model a complex problem as a hierarchical structure that shows the relationship between the goal, primary criteria, sub-criteria, and alternatives, (ii) to integrate information and experience, and (iii) to measure relative magnitudes through a process of pair-wise comparisons" (Arunraj and Maiti, 2010). The proposed decision problem is generally formulated as follows:

- "m" alternatives: $A_1,..., A_m$ to be ordered/ranked;
- "n" decision criteria $C_1,...,C_n$ expressed through the EMAS III indicators I1, ... In to be used to perform the alternative ranking that means how well performs each alternative with reference to all chosen relevant criteria for a certain formulated objective.

With the help of a numerical preference scale, in this case is the Saaty's scale, for criteria $C_1,...,C_n$, each decision maker should be able to express his/her preferences structuring them within an hierarchy by offering for each considered criterion a preference. The same is valid for alternative $A_1,..., A_m$ when each decision maker should express his/her preferences for the proposed alternatives. For each decision maker the sum of the preferences for the criteria/alternatives should equal 1. AHP proposes first to consider each criterion at a time in order to rank the alternatives. If for example "m" alternatives should be compared in the terms of one criterion, to make a hierarchy according to our preference the following steps are considered:

- a $[m\ x\ m]$ matrix, named the "pair wise comparison matrix" is written;

- any entry in the row "j" and column "k" is named in this case pjk where j=1÷m and k=1÷m;
- each entry p_{jk} shows how important is the alternative "j" when compared to the alternative "k" and the importance of the choice is measured on Saaty scale (1980) using integers from 1÷9.

To represent the assessor/evaluator preference for the more valuable of any two alternatives a score from this scale is given for each alternative. The score has the significance given in Table 1 based on Saaty's explanations.

The basic principle of AHP is making pair wise comparisons. When two parameters should be compared (whether there are criteria or alternatives) the methodological process considers one pair at a time. For example for a decision-maker/assessor if two or more alternatives should be compared with the reference to one single criterion the process is as follows. For the simplicity, alternatives will be further denoted with alphabetic letters. A and B for example are compared one to another taking into account one criterion - criterion 1 - in order to represent the degree of preference for the most valuable/important one. When the entry $p_{A,B}$ is greater than 1 then the alternative in the row is more important than the alternative in the column. If this is not the case, then the alternative in the row is less important than the alternative in the column. One such example is given in the Table 2. In this table, comparing alternative B (row 2) with alternative A (column 1) corresponds to the entry $p_{B,A}$=3 that is read according to Table 1: alternative B is slightly more important than the alternative A, while comparing alternative A (row 1) with alternative B (column 2) corresponds to the entry $p_{A,B}$=1/3 that is read: alternative A is slightly less important than alternative B resulting that ($p_{B,A}$) x ($p_{A,B}$) = 1. For three alternatives A, B and C the following judgment (pair wise comparison matrix) is produced by a generic evaluator.

3. Case study

A simulated case study that represents an usual situation that arises in any EMS organization analysis is given as possible example in order to exemplify the use of EMAS III indicators with AHP.

Problem Formulation:

Suppose that an organization environmental policy and program stipulates for the current year that the following three environmental targets should be met to improve the overall organization environmental performance goal:
1. the water emissions reduction with 10% with reference to the current status ;
2. the air emissions reduction with 30% with reference to the current status;
3. the increase of environmental investments with 2% with reference to the last year status.

To fulfill those targets the best investment alternative course of action (presented in Table 3) should be chosen analyzing the values and trends of EMAS III organization relevant indicators for air and water emissions areas. The chosen indicators among EMAS III organization indicators to be analyzed are presented next with values and comments.

Table 1. Explanation of value rating judgments based on Saaty Scale

Value rating lexical judgments (p_{jk})	***Lexical judgments***	***Explanation of intensity of importance expressed by lexical judgments***
(0)	(1)	(2)
1	**Equally important**	The two compared alternatives are assessed as **equally important**
3	**Slightly more important** one than another	The two compared alternatives are assessed as one being **slightly more important** than the other
5	**A lot more important** one than another.	The two compared alternatives are assessed as one being **a lot more important** than the other
7	**Considerable more important** one than another	The two compared alternatives are assessed as one being **considerable more important** than the other
9	**Absolute more important** one than another	The two compared alternatives are assessed as one being **absolutely more important** than the other
2, 4, 6, 8	Intermediate values between two adjacent assessments/choices	They show the intermediate states between two given assessments. For e.g. 4 **should characterize a state in between 3-slightly more important** and 5-**a lot more important.**

Table 2. An example of pairwise comparison matrix for the alternative A, B and C and the criterion 1

Criterion 1	***Alternative A***	***Alternative B***	***Alternative C***
Alternative A	$p_{A,A}$=1 $p_{A,A}$=1.000 (in decimal format)	$p_{A,B}$=1/3 $p_{A,B}$=0.333 (in decimal format)	$p_{A,C}$=2 $p_{A,C}$=2.000 (in decimal format)
Alternative B	$p_{B,A}$=3 $p_{B,A}$=3.000 (in decimal format)	$p_{B,B}$=1 $p_{B,B}$=1.000 (in decimal format)	$p_{B,C}$=6 $p_{B,C}$=6.000 (in decimal format)
Alternative C	$p_{C,A}$=1/2 $p_{C,A}$=0.500 (in decimal format)	$p_{C,B}$ =1/6 $p_{C,B}$ =0.167 (in decimal format)	$p_{C,C}$=1 $p_{C,C}$=1.000 (in decimal format)

Table 3. Alternatives description, advantages and disadvantages

Crt. No.	***Alternative***	***General description***	***Main advantages***	***Main disadvantages***
(0)	*(1)*	*(2)*	*(3)*	*(4)*
1.	A.	Air and water treatment equipment retrofitting at BAT (English acronym for Best Available Technique) level for the entire organization in order to reduce the air and water pollutants' emissions.	- less expensive than replacing the entire treatment equipment with new ones; - creates between 30÷50 new temporary local jobs for one year.	- the estimated investment value is the higher of the three proposed alternatives; - it exceeds the proposed objective/target from the environmental stated policy (i.e. an increase in current year with 2 % for ecological investments with reference to the last year value of 1%); It should be noted that: - the mentioned percentages are applied to the corresponding current year organization profit; - the present current year organization profit when this analysis is made is greater than last year organization profit (without mentioning if it is based on an increase of the production volume/amount or other basis such product diversification etc.); - using this alternative A, the increase of ecological investments is estimated at 3% applied to the organization current year profit.
2.	B.	Air treatment equipment retrofitting at BAT level for the entire organization in order to reduce the air pollutants' emissions	- less expensive than replacing the entire treatment equipment with new ones for air emission reduction; - creates between 10÷20 new temporary local jobs for one year.	- the estimated investment value is 30% of the value of alternative A; - it does not exceed the proposed 2% objective/target of increasing ecological investments with reference to the last year.
3.	C.	Water treatment equipment retrofitting at BAT level for the entire organization in order to reduce the water pollutants' emissions	- less expensive than replacing the entire treatment equipment with new ones for water emission reduction; - creates between 20÷30 new temporary local jobs for one year.	- the estimated investment values is 70% of the value of alternative A; - it does not exceed the 2% proposed objective/target of increasing ecological investment with reference to the last year.

For the air emissions segment:

1. Operation Performance Indicators:

- (I_1-a) – No. of equipments for air emissions reduction in place and functional in the organization /No. of equipments for air emissions reduction necessary according to the current level of production;

Comments: value of ratio <1; (shows the need for more equipment).

2. Environmental Conditions Indicators:

- ($I_{2.1.}$-a) - Annual air pollutants discharged in the atmosphere with adequate BAT compatible treatment/treatment equipment (in Kg)/Last year annual output (in kg): value of ratio = x1;
- ($I_{2.2.}$-a) - Annual air pollutants discharged in the atmosphere without adequate BAT compatible adequate treatment /treatment equipment (in Kg)/ Last year: annual output (in kg) value of ratio=x1';

Comments: x1<x1'; (shows efficiency of BAT and the need for more equipment).

- ($I_{2.3.}$-a) - Annual air pollutants discharged in the water with BAT compatible adequate treatment/treatment equipment (in Kg)/Last year annual output (in Kg): value of ratio = x2;
- ($I_{2.4.}$-a) - Annual air pollutants discharged in the water without BAT compatible adequate treatment/treatment equipment (in Kg)/Last year annual output (in Kg): value of ratio = x2';

Comments: x2<x2'; (shows efficiency of BAT and the need for more equipment).

3. Management Performance Indicators:

- ($I_{3.1.}$-a) - Percentage of the total profit reinvested in air emissions reduction equipments in last year/Percentage of the total profit reinvested in air emissions reduction equipments last two years: value of ratio < 1.

Comments: value of ratio < 1; (shows that investments on air emission reduction equipments have a decreasing trend in the last two years).

- ($I_{3.2.}$-a) -The value of fines in the last year for exceeding the annual amount of permit for atmospheric pollutants discharges/The value of fines in last two years for exceeding the annual amount of permit for atmospheric pollutants discharges: value of ratio >1.

Comments: value of ratio >1 (but only slightly); (shows that fines for exceeding permit for atmosphere discharges has an increasing trend in last two years-the money are spent on fines)

Note: The average values of fines on air segment are usually smaller than for the water segment in the last three years (shows that the atmosphere is more protected than the water which is good but improvement should be made also on water).

For the water emissions segment:

1. Operation Performance Indicators:

- (I_1-w) - No. of organization production facilities with functional local treatment water plants/No. of organization production facilities with local treatment water plants necessary in the organization according to the current level of production:

Comments: value of ratio <1; (shows the need for more equipment (functional))

2. Environmental Conditions Indicators:

- ($I_{2.1}$-w) - Annual pollutants discharged in the water body with adequate BAT compatible treatment/treatment equipment (in kg)/Last year annual output (in kg): value of ratio=x1;

- ($I_{2.2.}$-w) - Annual pollutants discharged in the water body without adequate BAT compatible treatment /treatment equipment (in kg)/Last year annual output (in Kg): value of ratio=x1';

Comments: x1<x1'; (shows efficiency of BAT and the need for more equipment)

- ($I_{2.3.}$-w) - Annual water pollutants discharged in water body with adequate BAT compatible treatment/treatment equipment (in kg)/Last two years average for annual output (in kg): value of ratio=x2;

- ($I_{2.4.}$-w) - Annual water pollutants discharged in water body without adequate BAT compatible treatment/treatment equipment (in kg)/ Last two years average for annual output (in kg) value of ratio=x2';

Comments: x2<x2'; (shows efficiency of BAT and the need for more equipment)

3. Management Performance Indicators:

- ($I_{3.1.}$-w) - Percentage of the total profit reinvested in water emissions reduction equipments in last year/Percentage of the total profit reinvested in water emissions reduction equipments last two years: value of ratio < 1

Comments: value of ratio <1; (shows that investments on water emission reduction equipments have a decreasing trend in the last two years).

- ($I_{3.2.}$-w) - The value of fines in the last year for exceeding the annual amount of permit for pollutants water discharges/The value of fines in the last two years for exceeding the annual amount of permit for water pollutants discharges: value of ratio > 1

Comments: value of ratio > 1 (but only slightly); (shows that fines for exceeding permit on water has an increasing trend in last two years-the money are spent on fines)

Note: The average values of fines on water segment are usually greater than for the air segment in the last three years showing the water is less protected than the atmosphere so more improvement is needed also on water).

An indicator is expressed by letter "I" abbreviating the word indicator; subscripts show the type of indicators (e.g. 1 for Operational Performance Indicators - English acronym OPI, 2 for Environmental Condition Indicators - English acronym ECI, and 3 for Management Performance Indicators - English acronym MPI); subscript subdivisions represent the number of a certain indicator type (e.g. 2.1. represents first indicator 1 of type 2 i .e. ECI and "a" and "w" stand for "air" and respectively for "water".

Those three types of EMAS III indicators (OPI, ECI and MPI) will be considered as AHP criteria and will be analyzed in the simulated case study by a panel of three evaluators acting as follows: assessor I - the person responsible in the organization for all departments having air emissions, assessor II - the person responsible in the organization for all departments having water emissions, assessor III - the person responsible for the EMS for the entire organization.

The chosen panel of the three persons have been agreed on decision criteria and asked to express their opinions/preferences by filling in three forms containing empty judgment matrices similar to that presented in Table 2; those entries are presented in column (0) and will be processed in column (1) of the Tables 6, 7. Experimental application of AHP method for the simulated case study within the designed methodology has three steps:

I. Choosing a test panel (a group of relevant persons);

II. Presenting the problem (the simulated case study) to the chosen test panel in order to be analyzed in the view of improving the overall environmental performance that is "to determine which of the three analyzed alternatives is best to fulfill the three presented environmental policy targets "

III. Processing the information from the test forms.

The questions to be used in filling in the preference/importance assessment (pairwise comparison) matrices are:

a) Criteria weights selection:

1."To select appropriate alternative course of action for the organization which of these three chosen criteria is of great importance/priority to you in the alternative A ,B, C selection?"

Note: Based on his/her knowledge and experience each assessor is instructed to give an answer on the form using a quantitative value from Saaty Scale (Table 1 - Section 2) to help create a pair wise comparison matrix among the given criteria.

b) Alternative weights selection:

1."Considering criterion C1 = OPI which of the three alternatives course of action offers better solution to improve the overall organization environmental performance in relation to the above-mentioned objective (to fulfill the three environmental policy targets)?"

2."Considering criterion C2 = ECI which of the three alternatives course of action offers better solution to improve overall organization environmental performance in relation to the above-mentioned objective (to fulfill the three environmental policy targets)?"

3."Considering criterion C3 = MPI which of the three alternatives course of action offers better solution to improve overall organization environmental performance in relation to the above-mentioned objective (to fulfill the three environmental policy targets)?

The final selection should consider a hierarchical structure presented in the Table 4.

3. Discussion

Tables 6 to 10 present computational steps according to AHP algorithm used to process the assessors' answers given as pairwise comparison matrices.

The Table 6 presents the synthesis of the responses given by the three assessors I, II, III with reference to criteria (column (0)). In column (1) of the Table 6 at section a) is presented in brief the computation algorithm for the priority vector. Components w_i of the priority vector W are denoted having as superscript the assessor identification and as subscript the considered criterion and represent the computed weights given to each criterion by each assessor according to his/her pairwise comparison matrix from column (0). They are presented as final results in bottom of column (0) e.g. for Assessor I: $w^I_{C1}=0.3$, $w^I_{C2}=0.1$ $w^I_{C3}=0.6$.

In column (1) of the Table 6 at sections b), c), and d) is presented a computation algorithm for consistency checking of pair wise comparison matrix for each assessor. The method proposed by Saaty consists of computing the largest eigenvalue λmax of the matrix A and showing in Eq. (1) that:

$$\lambda_{max} \geq n \qquad (1)$$

if and only if A is consistent. An inconsistency index denoted CI_n is defined in Eq. (2) as:

$$CI_n = \frac{\lambda_{max} - n}{n-1} \qquad (2)$$

As Bozóki and Rapcsák (2008) show, "the inconsistency index in its own has no meaning, unless we compare it with some benchmark to determine the magnitude of the deviation from consistency". This benchmark for inconsistency was proposed by Saaty and denoted RI_n. It is computed as average value of the randomly obtained inconsistency indices through the process of taking a samples of 100 or more pair wise comparsion matrices $[n\ x\ n]$ n (n=2, 3 ,4.......) so that each element of the matrix can be randomly chosen from the proposed scale. Such estimate of RIn made by Saaty is presented in Table 5. Then, "the inconsistency ratio denoted CRn of a given pairwise comparison matrix A is defined in Eq. (3) by:

$$CR_n = \frac{CI_n}{CRn} \qquad (3)$$

If the matrix is consistent, then $\lambda_{max} = n$, so $CI_n=0$ and $CR_n=0$, as well" (Bozóki and Rapcsák, 2008). The values of CR are measures of consistency by measuring the inconsistency. Saaty stated that a departure/deviation from perfect consistency of 10% is acceptable for its scale trying to point this way to epistemic or cognitive uncertainty that may be brought by lexical values judgments involving vague characterization concepts used in our daily life assessments such are: slightly more important, a lot more important, considerable more important and absolute more important.

The same philosophy as presented above for Table 6 is valid also for Table 7, showing pairwise comparison matrices, priority vectors and consistency checking for the proposed A, B, and C alternatives with reference to each criterion for Assessor I. The computation for Assessor II and III are not shown but they are similar to those from Table 7.

The ranking with CR <0.1 accepted by the method is presented in Eqs. (4 - 6) corresponding to the evaluators (III), (I) and (II):

A = (0.400+0.135+0.251)/3=0.786/3=0.262 (4)

B = (0.372+0.412+0.496)/3=1.280/3=0.427 (5)

C = (0.229+0.452+0.253)/3=0.939/3=0.311 (6)

It represents the validation of the assessments made by the three assessors as long as CR <1 for all presented assessments as have been computed in the presented Tables 6 and 7.

Table 4. Structure with three hierarchical levels for the simulated case study

Goal Level	***Selection environmental course of action in order "to improve the overall organization environmental performance by meeting the three environmental policy targets"***								
Criteria Level	*C1=OPI*			*C2=ECI*			*C3=MPI*		
Alternative Level	Alt A	Alt B	Alt C	Alt A	Alt B	Alt C	Alt A	Alt B	Alt C

Table 5. Selection from Saaty estimation of RI

Matrix Order:"n"	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Table 6. Pairwise Comparison Matrices for the three assessors I, II, III for the criteria C1, C2, C3, priority vector computation i.e. relative criteria importance estimation and assessment consistency checking

Assessors' Pairwise Comparison Matrices of A (n x n) type with reference to the criteria C1, C2, C3, expressed in fractional numbers according to their fill in forms *Note: Final results after computation performed in column (1) are given at the bottom column (0) under assessor (I, II, III) computation results*	***Computation of priority vectors section a) and checking the consistency according to Saaty proposed method points b), c), d)***
(0)	*(1)*

a) In order to compute the weights for the corresponding pairwise comparisont matrix from column (0) the product "p" of every p_i entry within each row (expressed in decimal style format) is computed then, the root of order "n" is taken. That represents step a-1) that is followed by step a-2) that is making the sum of the founded values in step a-1.To get components w_i of the priority vector ***W***, the founded values in step a-1) are divided by the sum computed in step a-2) which actually represents the step a-3).The obtained results in step a-3) are given under w_i *which represents the components of the priority vector W*.The a-4) step is identifying the obtained w_i values with the new name given to show the assessor and the criteria. *The steps of computation are presented below:*

Assessor I Matrix (A)	C1=OPI	C2=ECI	C3=MPI
C1=OPI	1	3	1/2
C2=ECI	1/3	1	1/6
C3=MPI	2	6	1

a-1)	**a-2)**	**a-3)**	w_i	**a-4)**
p=(1.000)(3.000)(0.5000)=(1.500)$^{1/3}$=1.144	***1.145***	1.147/3.817 =***0.3***	***0.3***	$=w^I_{C1}$
p=(0.333)(1.000)(0.0.167)=(0.056)$^{1/3}$=0.383	***0.383***	0.383/3.817 =***0.1***	***0.1***	$=w^I_{C2}$
p=(2.000)(6.000)(1.000)=(12.000)$^{1/3}$=2.289	***2.289***	2.289/3.817 =***0.6***	***0.6***	$=w^I_{C3}$
	Σ=3.817		***Σ=1***	

b) In order to check the consistency of each assessor the eigenvector and its value should be computed according to the formula (1) (Zheng et al., 2012):

$\lambda_{max} = 1/n \, \Sigma_{i=1 \div n} (AW)_i / w_i$ **(1)**

where ***A*** is the Assessor I matrix (the values written in decimal style format) and ***W*** is the priority vector with the w_i *components n=3 and computation* are presented bellow:

A				***W***		$\Sigma_{i=1\div n}(AW)_i / w_i$		λ_{max}
1.000	3.000	0.500		**0.300**		**3x0.300/0.3=3.000**	***3.000***	***9.000/3***
0.333	1.000	0.167	**x**	**0.100**	**=**	**3x0.100/0.1=3.000**	***3.000***	
2.000	6.000	1.000		**0.600**		**3x0.600/0.6=3.000**	***3.000***	
							Σ=9.000	***=3.000***

c)With λ_{max} the CI value is computed as follows according to the formula (2) (Zheng et al., 2012):

$CI_n = (\lambda_{max} - n)/(n-1)$ ***...(2)***

$\mathbf{CI_n = (3.000-3)/(3-1) = 0.000/2 = 0}$

d)The value of CI_n is used to compute the $CR_n = \mathbf{CI_n/RI_n}$ (Zheng et al.2012) using the corresponding RI_n from the Saaty computation Table 5: **CR = 0.000 / 0.58=0** that shows no inconsistency 0.000<0.1

Computation results Assessor I	Comments
Computation results Assessor I: w^I_{C1}***=0.3,*** w^I_{C2}***=0.1,*** w^I_{C3}***=0.6;*** λ_{max} ***= 3.000*** ***CI=0.000*** ***CR=0.000 / 0.58 and 0.000<1***	**Comments:** ***perfect consistency***

Assessor II Matrix (A)	C1=OPI	C2=ECI	C3=MPI
C1=OPI	1	2	1/2
C2=ECI	1/2	1	1/4
C3=MPI	2	4	1

a-1)	**a-2)**	**a-3)**	w_i	**a-4)**
p=(1.000)(2.000)(0.500)=(1.000)$^{1/3}$ =1.000	***1.000***	1.000/3.500=***0.286***	***0.286***	$=w^{II}_{C1}$
p=(0.500)(1.000)(0.250)=(0.125)$^{1/3}$ =0.500	***0.500***	0.500/3.500=***0.143***	***0.143***	$=w^{II}_{C2}$
p=(2.000)(4.000)(1.000)=(8.000)$^{1/3}$ =2.000	***2.000***	2.000/3.500=***0.571***	***0.571***	$=w^{II}_{C3}$
	Σ=3.500		***Σ=1***	

Computation results Assessor II	Comments
Computation results Assessor II: w^{II}_{C1}***=0.286,*** w^{II}_{C2}***=0.143,*** $^{II}_{C3}$***=0.571;λmax=3.000*** ***CI=0.000*** ***CR=0.000 / 0.58=0.000 and 0.000 < 0.1***	**Comments: perfect consistency**

(0)				*(1)*				
Assessor III Matrix (A)	C1=OPI	C2=ECI	C3=MPI	**a-1)**	**a-2)**	**a-3)**	w_i	**a-4)**
C1=OPI	1	2	1/4	p=(1.000)(2.000)(0.250)=$(0.500)^{1/3}$=1.794	***0.794***	0.794/4.366 = ***0.182***	***0.182***	$=w^{III}_{C1}$
C2=ECI	1/2	1	1/8	p=(0.500)(1.000)(0.125)=$(0.0625)^{1/3}$=0.397	***0.397***	0.397/4.366 =***0.091***	***0.091***	$=w^{III}_{C2}$
C3=MPI	4	8	1	p=(4.000)(8.000)(1.000)=$(32.000)^{1/3}$=3.175	***3.175***	3.175/4.366 =***0.727***	***0.727***	$=w^{III}_{C3}$
					Σ=4.366		***Σ=1***	
Computation results Assessor III: w^{III}_{C1}=0.182, w^{III}_{C2}=0. 091, w^{III}_{C3}=0.727; ***λmax =3.000*** ***CI=0.000*** ***CR=0.000 / 0.58=0.000 and 0.000 < 0.1***				**Comments: perfect consistency**				

Table 7. Pairwise Comparison Matrices for the Assessor I, for alternatives A, B, C with respect to C1, C2, C3 criteria taken one at a time, priority vector computation i.e. relative alternative weights importance estimation for each criterion and assessment consistency checking

Assessor I Pairwise Comparison Matrices of A (m x m) type with reference to the alternatives A, B, C and each criterion expressed in fractional numbers according to their fill in forms *Note: Final results after computation performed in column (1) are given at the bottom of column (0) under the Assessor I computation results*				***Computation of priority vectors for alternatives A, B, C with reference to one criteria at a time and checking the consistency as in Table 6 column (1) – steps a-1), a-2), a-3) where "n" is replaced with "m" and m=3 The a-4) step is identifying the obtained w_i values with the new name given to show the assessor I and the alternative-criterion as subscript. The steps of computation are presented below:***				
(0)				*(1)*				
Assessor I-criterion 1 Matrix (A)	A	B	C	**a-1)**	**a-2)**	**a-3)**	w_i	**a-4)**
A	1	1/4	1/2	p=(1.000)(0.250)(0.500)=$(0.125)^{1/3}$=0.500	***0.500***	0.500/3.500= ***0.143***	***0.143***	$=w^{I}_{A,C1}$
B	4	1	2	p=(4.000)(1.000)(2.000)=$(8.000)^{1/3}$=2.000	***2.000***	2.000/3.500=***0.571***	***0.571***	$=w^{I}_{B,C1}$
C	2	1/2	1	p=(2.000)(0.500)(1.000)=$(1.000)^{1/3}$=1.000	***1.000***	1.000/3.500=***0.286***	***0.286***	$=w^{I}_{C,C1}$
					Σ=3.500		***Σ=1***	
(0)				*(1)*				
Computation results Assessor I criterion 1: $w^{I}_{A,C1}$**=0.143,** $w^{I}_{B,C1}$**=0.571,** $w^{I}_{C,C1}$**=0.286.** ***$λ_{max}$ = 3.001*** ***CI=0.001 / 2=0.00005*** ***CR=0.0005 / 0.58=0.0009 and 0.0009 <0.1***				**Comments: no inconsistencies**				
Assessor I-criterion 2 Matrix (A)	A	B	C	**a-1)**	**a-2)**	**a-3)**	w_i	**a-4)**
A	1	1/2	1/4	p=(1.000)(0.500)(0.250)=$(0.125)^{1/3}$=0.500	***0.500***	0.500/3.500= ***0.143***	***0.143***	$=w^{I}_{A,C2}$
B	2	1	1/2	p=(2.000)(1.000)(0.500)=$(0.100)^{1/3}$=1.000	***1.000***	1.000/3.500=***0.286***	***0.286***	$=w^{I}_{B,C2}$
C	4	2	1	p=(4.000)(2.000)(1.000)=$(8.000)^{1/3}$=2.000	***2.000***	2.000/3.500=***0.571***	***0.571***	$=w^{I}_{C,C2}$
					Σ=3.500		***Σ=1***	
Computation results Assessor I criterion 2: ***$w^{I}_{A,C2}$=0.143, $w^{I}_{B,C2}$=0.286, $w^{I}_{C,C2}$=0.571.*** ***λmax =3.001*** ***CI=(3.001-3) / (3-1)=0.001/2=0.0005*** ***CR=0.0005 / 0.58=0.0009 and 0.0009 <0.1***				**Comments: no inconsistencies**				
Assessor I-criterion 3 Matrix (A)	A	B	C	**a-1)**	**a-2)**	**a-3)**	w_i	**a-4)**
A	1	2	4	p=(1.000)(2.000)(4.000)=$(8.000)^{1/3}$=2.000	***2.000***	2.000/3.500= ***0.571***	***0.571***	$=w^{I}_{A,C3}$
B	1/2	1	2	p=(0.500)(1.000)(2.000)=$(1.000)^{1/3}$=1.000	***1.000***	1.000/3.500=***0.286***	***0.286***	$=w^{I}_{B,C3}$
C	1/4	1/2	1	p=(0.250)(0.500)(1.000)=$(0.125)^{1/3}$=0.500	***0.500***	0.500/3.500=***0.143***	***0.143***	$=w^{I}_{C,C3}$
					Σ=3.500		***Σ=1***	
Computation results Assessor I criterion 3: ***$w^{I}_{A,C3}$=0.571, $w^{I}_{B,C3}$=0.286, $w^{I}_{C,C3}$=0.143.*** ***λmax =3.001*** ***CI=(3.001-3) / (3-1)=0.001/2=0.0005*** ***CR=0.0005 / 0.58=0.0009 and 0.0009 <0.1***				**Comments: no inconsistencies**				

Table 8. Assessment computation for assessor I

Assessor I	*C1*	*C2*	*C3*	*Preference alternatives computations*
	0.3	*0.1*	*0.6*	
A	0.143	0.143	0.571	(0.143 x 0.3) + (0.143 x 0.1) + (0.571 x 0.6) = 0.043 + 0.014 + 0.343 = 0.400
B	0.571	0.286	0.286	(0.571 x 0.3) + (0.286 x 0.1) + (0.286 x 0.6) = 0.171 + 0.029 + 0.172 = 0.372
C	0.286	0.571	0.143	(0.286 x 0.3) + (0.571 x 0.1) + (0.143 x 0.6) = 0.086 + 0.057 + 0.086 = 0.229

Table 9. Assessment computation for assessor II

Assessor II	*C1*	*C2*	*C3*	*Preference alternatives computations*
	0.286	*0.143*	*0.571*	
A	0.152	0.152	0.122	(0.152 x 0.286) + (0.152 x 0.143) + (0.122 x 0.571) = 0.043 + 0.022 + 0.070 = 0.135
B	0.218	0.218	0.559	(0.218 x 0.286) + (0.218 x 0.143) + (0.559 x 0.571) = 0.062 + 0.031 + 0.319 = 0.412
C	0.630	0.630	0.319	(0.630 x 0.286) + (0.630 x 0.143) + (0.319 x 0.571) = 0.180 + 0.090 + 0.182 = 0.452

Table 10. Assessment computation for assessor III

Assessor III	*C1*	*C2*	*C3*	*Preference alternatives computations*
	0.182	*0.091*	*0.727*	
A	0.539	0.539	0.143	(0.539 x 0.182) + (0.539 x 0.091) + (0.143 x 0.727) = 0.098 + 0.049 + 0.104 = 0.251
B	0.297	0.297	0.571	(0.297 x 0.182) + (0.297 x 0.091) + (0.571 x 0.727) = 0.054 + 0.027 + 0.415 = 0.496
C	0.164	0.164	0.286	(0.164 x 0.182) + (0.164 x 0.091) + (0.286 x 0.727) = 0.030 + 0.015 + 0.208 = 0.253

4. Conclusions

In conclusion we should ask a question: "is this methodology able to demonstrate and document organization's pro-active attitude towards sustainable development?" And the answer is yes for a number of key reasons:

1) It is an evidence-based chain of reasoning method that can document the analysis/decision process increasing firm/organization accountability;

2) It is practical instrument to involving the employees/stake-holders in a democratic, participatory manner in the environmental decision process using consensual agreed decision criteria making the assessment process less prone to subjectivity;

3) It is special dedicated for group decision in order to reach timely conclusions during planned environmental management analysis

4) It can generate synthetic reports, reducing the unnecessary paper work the algorithm being easily automated.

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