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The contribution of the ERA to the selection of the environmental indicators and to the allowance of the environmental objectives

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Abstract

Purpose – This paper is interested to assist organizations in the task of selecting and use appropriate indicators for their environmental evaluation procedure (EPE). This maximizes the successful deployment of the EPE process and as a consequence the introduction of good environmental practices. The paper aims to discuss these issues.
Design/methodology/approach – It consists of a proposal for a combined methodology based on the simultaneous use of environmental risk (ER) approach and RPN-based allocation method.
Findings – In the developed methodology, the authors use the principles of risk assessment and purpose a new formulation of weight allowance with reference to the severity of ERs and significance of environmental aspects.
Practical implications – Methodology suggested constitutes an invaluable help to implementation EPE process and as a consequence the introduction of good environmental practices.
Originality/value – Methodology suggested facilitates the process of environmental performance evaluation providing substantial assistance to one of the most important stages that is to decide which particular indicators will be considered.

Keywords Sustainable environment, Risk, Indicator, Development policies, Goal, Allocation
Paper type Research paper

Nomenclature

EI_{ji}	Environmental indicator
PEI_{ji}	Prioritized environmental indicator
ER_{ji}	Environmental risk of indicator EI_{ji}
SEA_i	Significance of environmental aspect "i"
EG_i	Environmental goal related to the environmental aspect "i"
NI_{EA_i}	Importance level of the environmental aspect "i"
NM_{EA_i}	Control level of the environmental aspect "i"
SS_{EA_i}	Sensibility of the site and its surrounding at this environmental aspect "i"
F_{ji}	Frequency of failure to achieve the related goal
M_{ji}	Magnitude of the negative impacts in case of failure to achieve the related goal
S_i^*	Tolerated significance for SEA_i
S_i	Real significance for SEA_i
W_{S_i}	Weight of allocation related to the significance S_i
ER_{ji}^*	Sub-goals related to environmental risk ER_{ji}
$W_{PEI_{ji}}$	Weight of allocation related to the prioritized indicator PEI_{ji}
N_{PEI/SEA_i}	Number of prioritized indicators related to a SEA_i

World Journal of Science, Technology and Sustainable Development
Vol. 12 No. 1, 2015
pp. 61-78

2042-5945
DOI 10.1108/WJSTSD-08-2014-0022

1. Introduction

In the environmental management, the environmental performance evaluation (EPE) is defined as (ISO 14031, 1999): "a process to facilitate management decisions regarding an organization's environmental performance by selecting indicators, collecting and analyzing data, assessing information against environmental performance criteria, reporting and communicating, and periodic review and improvement of this."

Although EPE has been considered to be both significant and useful, it is an area still susceptible for further research and development work (Diakaki *et al.*, 2006; Myhre *et al.*, 2013; Hua *et al.*, 2014; Zhang *et al.*, 2014). This is partly due to the fact that an evaluation is not an easy task, given the resources and efforts that are required, and partly due to the fact that the adoption of EPE procedures is still an optional task (Retief, 2007; Boatemaa *et al.*, 2013). This fact in combination with the difficulties that arise when an organization tries to implement EPE, reduce its extensive use. Diakaki *et al.* (2006) recall that a first problem relates to the resources necessary for such a task and the second problem concerns the choice of environmental indicators (EI).

According to Diakaki *et al.* (2006), the environmental performance indicators (EPIs) used by EPE are as defined by Bartolomeo (1995) "the quantitative and qualitative information that allow the evaluation, from an environmental point of view, of company effectiveness and efficiency in the consumption of resources."

The indicators depend on (Barrie, 1990; Rhys *et al.*, 2005): the objectives defined by the organizations, interests of the stakeholders which decide to take into account and the situation of the organizations in terms of size, geographical implantation, and branch of industry. As a consequence, it is really difficult for an organization to decide which particular indicators should be included in the EPE procedure.

The aim of the method proposed in this paper is to assist organizations in the difficult task of selecting appropriate indicators for their EPE procedures. This maximizes the successful deployment of the EPE process and as a consequence the introduction of good environmental practices.

The proposed methodology is based on the environmental risk assessment (ERA) approach (Eduljee, 1998; Llewellyn, 1998) which is a process for estimating the likelihood or probability of an adverse outcome or event due to pressures or changes in environmental conditions resulting from human activities (Topuz *et al.*, 2011). ERA is complementary to methods used in: state of environment reporting (Fairman *et al.*, 1999), environmental impact assessment and risk management (Arslan, 2009; Marcelino-Sádaba *et al.*, 2014).

The ERA approach involves identification, analysis and presentation of information in terms of risk to environmental values to inform planning and decision-making processes (Kolluru *et al.*, 1996; Aven and Kristensen, 2005).

ERA is a flexible tool that can be applied in many fields and has extensively been used in a variety of environmental issues (Tixier *et al.*, 2002; Darbra *et al.*, 2008), since the 1970s when it was initially developed as a technique and a profession under the general term ERA (Ball, 2002).

In this study, ERA is mainly used as an identification and prioritization tool to assist decision- making on the selection and the use of appropriate indicators for EPE by a proposal method of allowance of the environmental objectives which we have coupled with ERA method.

In this context, this paper includes five more sections. The next one describes the background of the presented study including a short state-of-the-art review on the progress area of EPE and ERA. The third section presents the proposed methodology, while the fourth section describes the application of the methodology to a tannery industry. Finally, the last section summarizes the finding of the suggested methodology and recommendations that arise from the overall study.

2. The ERA and EPE approaches

2.1 The ERA approach

The ERA is a powerful technical and analytical set of instruments for analyzing adverse environmental impacts. In this way, it can provide scientific evidence for environmental decision-making, and therefore has been widely applied across the world over the past several decades (Wu and Zhang, 2014).

With the development of decision analysis techniques, the application of ERA has widened since the late of 1980s to provide scientific evidence for environmental management (Eduljee, 2000). For example, risk evaluation based on Benefit-Cost Analysis (Mellal and Djebabra, 2014), and comparative risk assessment based on methods of indicators selection (Diakaki *et al.*, 2006) or on methods of Multi-Criteria Decision Analysis (Jafar *et al.*, 2013).

The advantage of the latter two categories of methods is that they are aimed for prioritizing EI.

All methods focussed on "risk assessment" or on "comparative risk assessment" illustrate the first type of ERA called "ERA for decision-making process," while the other type of ERA is called traditional ERA, which include (Wu and Zhang, 2014): health risk assessment, risk assessment accident, natural disaster risk assessment and regional comprehensive risk assessment.

Some examples of the use of ERA are given below (Environment Health and Safety Committee EHSC, 2013):

- Assessing the impacts of chemicals used at existing sites.
- Assessing the impacts of products generated by individual companies/sites due to their use or transport.
- Assessing potential impacts of new developments, new sites or new processes as part of the planning procedure.
- Assessing the impacts of products, processes or services over their life cycle.
- Consideration of risks to the environment in a company's environmental management system (EMS) or eco-management and audit scheme (EMAS).
- Registration, Evaluation, Authorization and Restriction of Chemicals Regulation.

ERA can be thought of as containing the following key stages (Environment Health and Safety Committee (EHSC), 2013): hazard identification, identification of consequences if the hazard was to occur, estimation of the magnitude of the consequences, estimation of the probability of the consequences and finally evaluating the significance of a risk.

Given the wide range of use of the ERA and considering these main steps mentioned above, its deployment in EPIs is not only easy (see Section 3), but also very useful. Because it allows to capitalize the results of the EPIs so that they become (Schaltegger *et al.*, 1996): comprehensible by non-scientists, suitable for an organization's environmental and social targets as well as to the information requirements of stakeholders, reliable and comparable across different organizations and relevant benchmarks.

Moreover, and as the general framework of EPIs is EPE, the ERA for decision-making process can be a valuable help to solve some problems of the EPE which are presented in the next section.

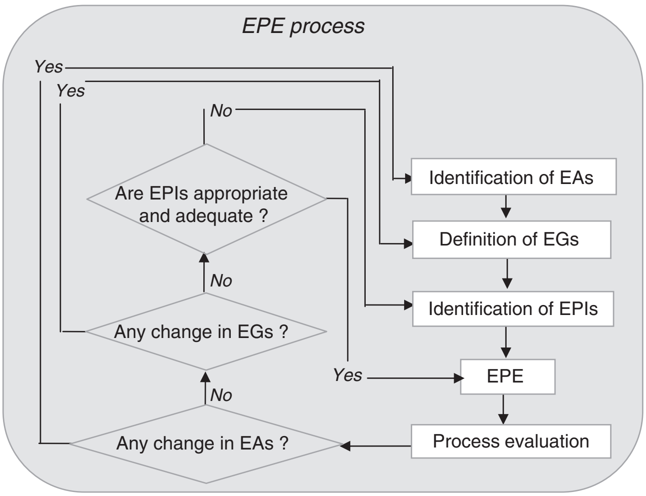
2.2 Problems of EPE elements

The EPE is framed by the establishment management tools recommended by the ISO 14000 standards, such as EI that allow not only a permanent measurement of the environmental performance but also a means of communicating information with environmental stakeholders.

In addition, EI reduce the number of parameters from measurements to account for the often complex environmental situation. In this sense, indicators can simplify the understanding and interpretation of the results by providing to the target synthetic information easily accessible to enable them to integrate the environment into their decisions and their behavior. It is therefore important to optimize the number of indicators that reflect a situation: too many indicators make the results confusing and obscure the vision of the whole, while too few indicators may not be representative.

Regardless of the optimization problem of indicators in which we return at the end of this section, EPE requires the identification and assessment of appropriate performance indicators (Tyteca, 1996). To this end, the following generic approach (see Figure 1) has been followed for EPE:

- *Identification of environmental aspects (EA)*. At this stage, the EA of the industry's activities are identified and reported. In this context, (Berkhout *et al.*, 2001) concluded that some EA are generally applicable (e.g. the energy use and the water consumption), while others are specific to certain production processes.



Source: Diakaki *et al.* (2006)

Figure 1. The industry's EPE process

- *Definition of environmental goals (EG)*. At this stage, given the environmental aspects of the industry's activities, goals are set regarding the reduction of any potential environmental impacts.
- *Identification of EI*. Given the output of the previous two stages, at this stage, several EI that may be considered for the EPE of the industry is defined. Each indicator in this initial set is identified in order to monitor the achievement or otherwise of an environmental goal in relation to the environmental aspects of the industry's activities. At this level, it is important to note that the initial list of indicators should be composed of few indicators that will be expanded annually by additional indicators in the implementation of specific measures and actions for improvement.
- *EPE*. The evaluation of the environmental performance of the industry takes place at this stage using the indicators selected within the previous stage.
- *Process evaluation*. At this final stage, the evaluation of the whole process takes place. The results of the EPE are examined in order to identify potential deviations from the desired process outcomes. In case that no deviation is observed the EPE process continuous as it stands. Otherwise, the process may return to Stage 1, 2, 3, or 4, according to the output of the process evaluation, in order to take any necessary corrective actions.

All steps of the EPE presented above require the following remarks:

(1) *Identification of EA*. In this step, it is not to formulate proposals for improvement over the state of the environment, but to make observations. From the environmental aspects analyzed that some of them can be described as "significant." In this context, the ERA approach is an ideal setting for assessing the significance of these aspects, because it is based on that assessment, that the significant environmental aspects will be prioritized and selected in the environmental program.

(2) *Definition of EG*. Attention is often paid to the definition of EG in order to reduce significant environmental impacts. The EG should be allocated into sub-goals in order to better implement the environmental program (Saadi *et al.*, 2011). In this context, the ERA approach also adapts to integrate the allocation of environmental goals.

(3) *Identifying EI*. Whatever the initial list of EI identified, they should be selected to prioritize the most representative EI. Again, the ERA approach is best suited to perform this prioritization (i.e. EI optimization) according to their related environmental significance. Based on this prioritization, the retained EI are those which have a high ER.

(4) *EPE and process evaluation*. The EPE is based on the EI selected from the environmental aspects considered as significant. The obtained results allow EPE: either to supply the results provided by the ERA approach (i.e. update significance of the environmental aspects following a feedback) or to mobilize more EI for a better EPE. Consequently, the ERA approach and EPE process are complementary and even strongly dependent.

The brief overview of the EPE shows that its application depends on a judicious choice of EI. The advantage of the suggested methodology detailed in the next section is that it offers us the opportunity to make this choice through the term ER. Furthermore and as EI is a continuous measurement of environmental performance in terms of improvement of fixed goals and targets, so it is imperative to use these indicators through a method of allocating environmental goals which is an integral part of the suggested methodology detailed below.

3. The suggested methodology

The suggested methodology is based on the principles of the ERA approach which completed by the allowance of environmental objectives. This complementarity is justified by the fact that the finality of ERA approach is to reduce the ER and this reduction depends on: the requirements and goals that have been set at the environmental program, the probability of failure to achieve these requirements and goals, and the consequences that may result from the failure to achieve these requirements and goals.

The steps of the proposed methodology and its relationship with the EPE process are provided in Figure 2 where step 1 of the proposed methodology is the formulation of the problem which consists in the identification of environmental aspects, indicators, and related environmental goals. This step is powered entirely by the information provided by the steps 1 to 3 of EPE process.

On the basis of this formulation, the second step of the proposed methodology permits the calculation of the environmental aspect significance (S_{EAi}) whose values range from 1 (negligible significance) to 1,000 (very high significance). This significance is based on the multiplication of three assessments graded from 1 to 10, assigned to the following parameters (see Equation (1)):

- Importance level (IL_{EA_i}): severity, intensity or frequency of occurrence of the studied environmental aspect.
- Control level (CL_{EA_i}): technical, human or organizational of this aspect by the organization.
- The sensibility of the site (SS_{EA_i}) and its surrounding at this environmental aspect.

The significance of an environmental aspect is provided by the Equation (1):

$$S_{EA_i} = IL_{EA_i}.CL_{EA_i}.SS_{EA_i} \qquad (1)$$

In this study, an environmental aspect is considered significant when it exceeds, for each criterion (importance, control, and sensibility), the values of $5 \times 5 \times 5$, i.e. 125.

In the third step of the methodology, for each significant environmental aspect (SEA_i), are calculated the ERs of indicators (ER_{ji}).

For a rational decision-making regarding the assessment of the risk, the requirements and goals that have been set at the strategic planning of the system, the probability of failure to achieve these requirements and goals, and the consequences that may result from the failure to achieve these requirements and goals, should be considered. To this aim, for the assessment of the ER of an indicator, the following variables need to be defined (see Equation (1)):

- Importance level (IL_{EA_i}): severity, intensity or frequency of occurrence of the studied environmental aspect.

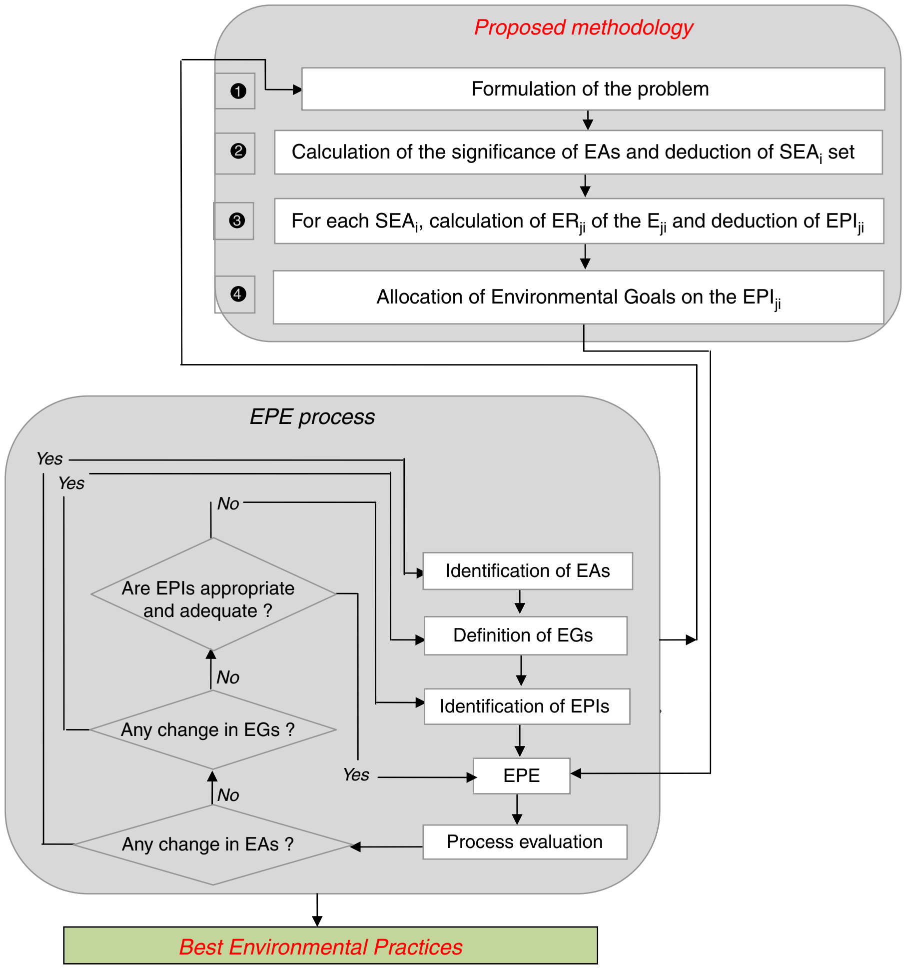


Figure 2.
Interaction EPE process – proposed methodology

- Control level (CL_{EA_i}): technical, human or organizational of this aspect by the organization.
- The sensibility of the site (SS_{EA_i}) and its surrounding at this environmental aspect.

Consequently, the environmental risk (ER_{ji}) related to a particular indicator (j) of environmental aspect (i) is calculated based on the product of this three parameters:

$$ER_{ji} = F_{ji}.P_{ji}.M_{ji} \tag{2}$$

In order to calculate the ER_{ji} value of a particular indicator, the related values of the three risk assessment variables F_{ji}, P_{ji}, and M_{ji} are required. These values may be estimated through the use of qualitative ordinal scales defined according to the assessed variable (see, e.g. the application of next section).

Following steps 2 and 3, only the significant environmental aspects and the prioritized EI will be retained in the followed proposed methodology.

The fourth and final step of the suggested methodology consists of an allocation of environmental goals related to SEA_i into sub-goals allocated on prioritized ERs associated to PEI_{ji}. This allocation of goals into sub-goals is based on the weighted methods of the type risk priority number based allocation methods (Kim *et al.*, 2013), whose general principle is provided by:

$$S_i^* \leqslant W_{S_i}.S_i \tag{3}$$

where S_i^* is the tolerated significance for a SEA_i; S_i is the real significance of a SEA_i estimated by Equation (1) and $W_{S_i}$is a weight of allowance.

In this study, the tolerated significance is equal to the value 125. Consequently, S_i^* is formulated by:

$$S_i^* = W_{S_i}.S_i \tag{3a}$$

This Equation (3a) permits to deduce the environmental goals related to different SEA_i (see, e.g. the application of next section):

$$EG_i = \omega_i \tag{4}$$

With $\omega_i = 1 - W_{S_i}$

The allocation of environmental goals into sub-goals is performed on the ERs associated to PEI_{ji}:

$$ER_{ji}^* = W_{PEI_{ji}}.ER_{ji} \tag{5}$$

In Equation (5), the formalization of allocation weight $W_{PEI_{ji}}$must take into consideration: environmental goal (EG_i) of Equation (4), the number of prioritized EI related to a significant environmental aspect (N_{PEI/SEA_i}) and the values of the corresponding ERs. Consequently, the allocation weight $W_{PEI_{ji}}$is expressed by Equation (6) which has the advantage of integrating the two cases where the ERs are considered equiprobable or not. (see, e.g. the application of next section):

$$W_{PEI_{ji}} = \frac{ER_{ji}}{\sum_{j=1}^{N_{PEI/SEA_i}} ER_{ji}} EG_i \tag{6}$$

Remark. In the special case where ERs are equiprobable, relation (6) becomes:

$$W_{PEI_{ji}} = \frac{1}{N_{PEI/SEA_i}} EG_i \tag{7}$$

4. Application to the tannery industry

The methodology described in the previous section, has been applied to tannery industries. This industry is one of the major consumers of fresh water and most of the water is discharged as wastewater (Bajza and Vrcek, 2001).

This industrial activity is selected to illustrate the methodology developed above. Moreover, these industrial activities affect the river water environment and thus lessen ecological balance (Shen, 1999). Consequently, the tanning industry is considered to be a major source of pollution and tannery wastewater in particular (Ros and Ganter, 1998). Indeed, the discharge of solid waste and wastewater containing chromium is the main environmental problem (Song *et al.*, 2000). Emissions into the air are primarily related to energy use, but also the use of organic solvents and dyes causes emissions into the air.

The tannery of Batna-Algeria is one of these tanneries which selected in this section to illustrate the application of the suggested methodology. Its flow diagram, indicating type of pollutants during the tanning process, is given by Figure 3.

This tannery established in 1973, ensures the transformation of raw animal skins into leather. Like any tannery, MEGABatna.Spa consumes large amounts of water which, once used, are removed by two networks: network river workshop and the workshop tanning. This water is treated at the purification plant before being released into the natural environment.

MEGABatna.Spa-Algeria is located in the northern industrial zone of Batna city (located in Eastern Algeria). It covers a total area of 48,376 m^2 with a covered area of 9,679 m^2. The manufacturing workshop area is 6,264 m^2. Its average production capacity is of 3,500-4,500 skins per day.

Pollutants emitted by MEGABatna.Spa-Algeria are subject to strict regulations particularly the Executive Decree No. 06-141 of April 2006 defining the limits of the discharge of industrial effluents values. Despite these regulatory requirements, in many cases, the discharges of the tannery exceed the permissible values, especially after slight disturbance of the functioning of the wastewater treatment plant. The water is then discharged into the receiving environment with high concentrations of chromium (300 mg/l), sulfide (800 mg/l) as well as suspended solids (up to 7,000 mg/l) without forgetting that these effluents have very large variations in pH (between 4 and 12) when it stops completely.

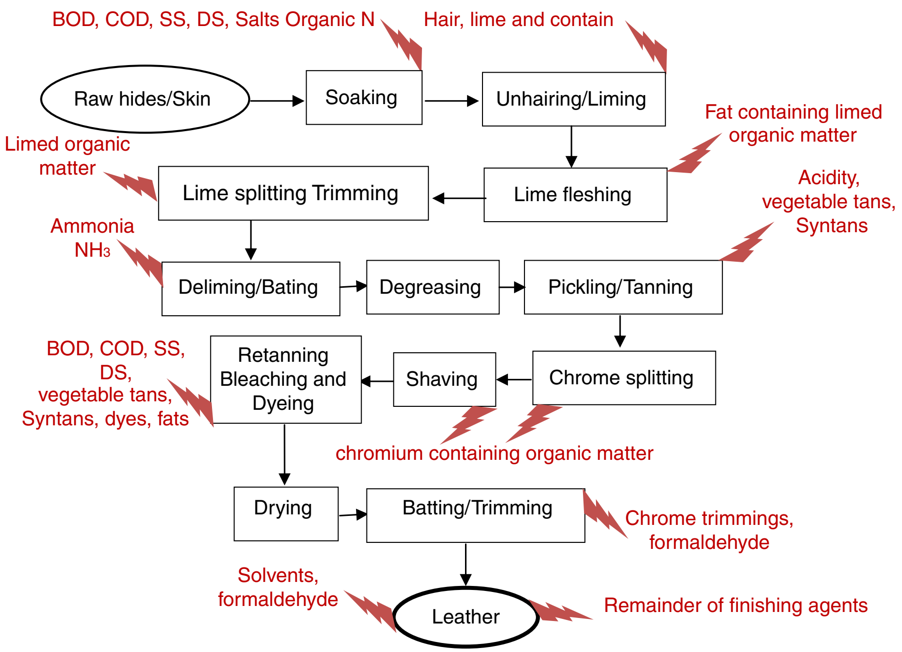


Figure 3.
Flow diagram of MEGABatna. Spa-Algeria with type of pollutants

Consequently, MEGABatna.Spa-Algeria was recently ranked among the companies that have eco-resistant behavior (Boubaker *et al.*, 2012). Recall that to improve its environmental performance, MEGABatna.Spa-Algeria must have at least an eco-conformist behavior and better eco-sensitive behavior (Boubaker *et al.*, 2012).

To improve its environmental behavior, MEGABatna.Spa-Algeria must implement a prevention of waste production plan focussed on the identification of the environmental significant aspects in order to reduce the negative impacts on the natural and human environment resulting from MEGABatna.Spa-Algeria activities. It is in this context that the application of the methodology, presented in the preceding section, was conducted by a series of following tasks: first, visit to MEGABatna. Spa-Algeria and surrounding areas; second, on-site assessments and interviews with relevant personnel including workers, managers, and other stakeholders; and third, preparation of the identification of environmental aspects report from the interviews.

In the application of the proposed methodology on the MEGABatna.Spa-Algeria, eight environmental aspects including 42 EI have been taken into consideration (Table I). Among the eight environmental aspects, six are considered significant ($SEA_i > 125$). A quick review of the 35 indicators for the six SEA shows that 37 percent are environmental management indicators, 46 percent are environmental operational indicators and 17 percent are environmental conditions indicators.

Based on interviews, the evaluation of the significance of environmental aspects (in Table I) is conducted through an identification of environmental aspects report designed specifically for the three parameters that express the significance (see Equation (1)).

During these interviews, each interviewee is considered as an expert, and estimates on ordinal scale from 1 to 10 the three parameters that express the significance of an environmental aspect (see Equation (1)). In total, 25 experts participated in the operations where15 are part of the unit personnel (qualified workers and managers) and ten stakeholders are external to the unit (four senior of civil protection, two members of the environmental administration and four university professors).

Given the quality of the experts chosen in these interviews, all the assessments provided by experts for each parameter of the significance of an environmental aspect were aggregated by their arithmetic means (Table I).

Following these assessments and considering the level fixed by the department (i.e. a significance level equal to 125), the impacts of EA_1-EA_6 are considered significant environmental impacts for which we have calculated the values of the corresponding ER_{ji} (Table II).

Table I. Identification and evaluation of environmental aspects

			Variables			
Environmental aspect		Number of EPIs	IL_{EA_i}	CL_{EA_i}	SS_{EA_i}	S_{EA_i}
SEA_1	Liquid wastes	6	10	7	9	630
SEA_2	Atmospheric emissions	6	10	7	6	420
SEA_3	Solid waste (activated sludge)	6	10	6	7	420
SEA_4	Water consumption	5	9	9	5	405
SEA_5	Consumption of raw materials	6	7	7	6	294
SEA_6	Electric energy consumption	4	7	9	4	252
	Scenery and living environment	5	5	4	6	120
	Transportation and infrastructure	4	4	5	5	100

Table II. Identification and evaluation of environmental indicators of MEGABatna. Spa-Algeria

SEA_i	Environmental indicators		Variables F_{ji}	P_{ji}	M_{ji}	ER_{ji}
Liquid wastes	EI_{11}	*Failure frequency of the treatment station of wastewater*	3	5	5	75
	EI_{21}	Number of days of nonconformity of the parameters	2	5	5	50
	EI_{31}	Total volumes of liquid waste m^3/year	3	4	4	48
	EI_{41}	Characteristics of liquid waste/Section	2	4	4	32
	EI_{51}	List of impact factors (Cr, BOD, COD, […])	2	4	4	32
	EI_{61}	Training/education of staff	2	3	3	18
Atmospheric emissions	EI_{12}	Annual quantity of dust and particles/VOC/NOx/SO_2 emitted	4	5	5	100
	EI_{22}	*Actions for managing odor nuisances*	5	4	5	100
	EI_{32}	Concentration of atmospheric pollutants	3	4	4	48
	EI_{42}	Number of complaints handled	3	4	4	48
	EI_{52}	Quantity of volatile materials stored in the open air	2	4	3	24
	EI_{62}	Atmospheric pollutant/section	2	3	3	18
Solid waste	EI_{13}	*Quantity of activated sludge/day*	4	5	5	100
	EI_{23}	Pollutants concentration	3	5	5	75
	EI_{33}	Activated sludge/section	3	4	4	48
	EI_{43}	Number of complaints handled	3	4	4	48
	EI_{53}	Quantity of sludges stored in the open air	4	3	3	36
	EI_{63}	Training/education of staff	2	3	3	18
Water consumption	EI_{14}	*Annual consumption of potable water*	5	5	5	125
	EI_{24}	Treatment price per m^3 of residual water	5	4	4	80
	EI_{34}	Consumption/section	3	4	4	48
	EI_{44}	Depth of groundwater and abstraction points	2	4	4	32
	EI_{54}	Training/education of staff	2	3	3	18
	EI_{64}	Loss rates of the internal net of potable water	1	3	3	9

(*continued*)

SEA_i	Environmental indicators		F_{ji}	Variables P_{ji}	M_{ji}	ER_{ji}
Consumption of raw materials	EI_{15}	*Control actions to reduce consumption*	4	5	5	100
	EI_{25}	Quantity of raw materials/year	2	5	5	50
	EI_{35}	Quantity/type of material	3	4	4	48
	EI_{45}	Quantity of rejected material//section	3	4	4	48
	EI_{55}	Number of complaints handled	3	4	4	48
	EI_{65}	Training/education of staff	2	3	3	18
Electric energy consumption	EI_{16}	*Energy consumed by source in the company (electricity, gas, other)*	5	4	3	60
	EI_{26}	Production of renewable energy	5	3	3	45
	EI_{36}	Distribution of different sources (%)	4	3	3	36
	EI_{46}	Electrical energy/section	4	3	3	36
	EI_{56}	Training/education of staff	2	3	3	18

Table II.

Following the results from Table II, only EI_{ji} which have a maximum ER_{ji} will be considered as prioritized environmental indicator (PEI_{ji}). In our case, they are seven in number, of which: 43 percent are environmental management indicators and 57 percent are environmental operational indicators (Table III).

The analysis of the results of Table IV shows the advantage of the environmental goals allocation related to PEI_{12} and PEI_{22}, where ER is considered equiprobable for both indicators ($ER_{12} = ER_{22} = 100$).

It is important to mention that the procedure of the allocation of an environmental goal (EG_i) proposed in the suggested methodology (Equations (5) and (6)) is applied only if the prioritization of EI performed based on the maximum value of the ERs related to indicators of SEA_i:

$$EI_{ji} \text{ is a } PEI_{ji} \text{ only if } ER_{ji} = \max\left(ER_{1i}, ER_{2i} \ldots ER_{ji}\right) \quad j = 1 \ldots N_{EI_i} \tag{8}$$

where N_{EI_i} is the number of EI of an EA_i.

Note that the allocation procedure of an environmental goal (EG_i) in environmental sub-goals remains valid in the case where the prioritization of EI is performed on the basis of a value that is not necessarily equal to the maximum value of the ERs related to indicators of SEA_i. To illustrate this, consider a prioritization level of EI equals to the minimum value of ER_{ji} (first line of Table IV):

$$\gamma = \min(ER_{11} + ER_{12} + ER_{22} + ER_{13} + ER_{14} + ER_{15} + ER_{16}) = 60 \tag{9}$$

For the γ level, two new indicators will be considered as prioritized indicators which are: PEI_{23} with ER_{23} equals 75 and PEI_{24} with ER_{24} equals to 80.

The results of the new environmental goals allocation of all the nine PEI_{ji} is presented in Table V.

SEA_i		Environnemental goals Definition	W_{Si}	EG_i
SEA_1	Liquid wastes	To reduce the quality of the rejections	0.198	80
SEA_2	Atmospheric emissions	To improve quality of the air by reduction of the atmospheric pollutants	0.297	70
SEA_3	Solid waste (activated sludge)	Suitable management of waste	0.297	70
SEA_4	Water consumption	To reduce water consumption	0.308	69
SEA_5	Consumption of raw materials	Rational use of the raw material	0.425	57
SEA_6	Electric energy consumption	To reduce consumption in power electric	0.496	50

Table III. Formulation of environmental goals of the MEGABatna. Spa-Algeria

				PEI_{ji}			
	PEI_{11}	PEI_{12}	PEI_{22}	PEI_{13}	PEI_{14}	PEI_{15}	PEI_{16}
ER_{ji}	75	100	100	100	125	100	60
N_{PEI/SEA_i}	1	2		1	1	1	1
$W_{PEI_{ji}}$	0.802	*0.351*	*0.351*	0.702	0.691	0.575	0.504
ER_{ji}*	*60*	*35*	*35*	*70*	*86*	*57*	*30*

Table IV. Results of environmental goals allocation

Finally, it should be noted that the results obtained by the proposed methodology (Tables I-V) show that the prioritization of EI does not exclude the use of other EI in the EPE process. It just indicates the environmental aspects and the related goals from which the management of the industry may start its EPE procedure.

Following the application of the suggested methodology based on ERA for the selection of EI, it is important to remember that the research work on the ERA into decision-making process are systematically focussed on an industrial activity (Jozi and Salati, 2012; Ostoich *et al.*, 2014) and there are no ERA methods in strategic decision-making process (Wu and Zhang, 2014). It is the major limit of the ERA into decision-making process.

In order to try the generalization of the ERA use for the strategic decision-making process we have to capitalize the results of this study in order to cover all Algerian tanneries.

In this context and to better illustrate the contribution of the suggested methodology in the Algerian tanneries, we recall that the biggest problem in Algerian tanneries is the absence of proper guideline to reduce pollution causes by these tanneries (Leghouchi *et al.*, 2009). Fortunately, 2013 was marked by a national action plan focussed on the best environmental practices in the Algerian tanneries (CPRAC, 2013). In addition to the Algerians tanneries responsible, stakeholders involved in this plan are: leather artisans, the Algerian Ministry of Regional Planning, Environment and Urban Development, National Center of Cleaner Technologies, the network of Maghreb Enterprises for the environment and the Chamber of trades and crafts.

The goal of this project is to present an ecological tannery using natural and local products and taking advantage of such solid waste (sludge) as agricultural fertilizer. As part of this unifying project (CPRAC, 2013), the suggested methodology permits to facilitate the use of the EPE process. So, its success is to facilitate the promotion of the environmental best practices in tanneries by the design of two documents:

(1) A Manual for environmental aspects assessment (EAAM) which will be useful as basic support for the EPIs selection according to the Algerian tanneries characteristics (in particular of their sizes).

(2) A Guideline for environmental impact assessment (EIAG) which is the first attempt to systematize the identification of the environmental impacts of Algerian tanneries. The second attempt of the EIA guidelines is to guide these tanneries to planning their environmental best practices and benchmarking reports by use the allowance of the environmental objectives.

Table V.
Results of environmental goals allocation for a level $\gamma = 60$

	PEI_{ji}								
	PEI_{11}	PEI_{12}	PEI_{22}	PEI_{13}	PEI_{23}	PEI_{14}	PEI_{24}	PEI_{15}	PEI_{16}
ER_{ji}	75	100	100	100	75	125	80	100	60
N_{PEI/SEA_i}	1	2		2		2		1	1
$W_{PEI_{ji}}$	0.802	*0.351*	*0.351*	0.401	0.301	0.421	0.270	0.575	0.504
ER_{ji}*	*60*	*35*	*35*	*40*	*30*	*53*	*34*	*57*	*30*

5. Conclusions

The aim of this research is to assist the organizations in the difficult task of selecting appropriate indicators for their EPE procedures. This maximizes the successful deployment of the EPE process and as a consequence the introduction of good environmental practices.

In academic implications, the results of the proposed methodology show the interest of the ERA approach combined with the allocation method for the selection of prioritized EI as well as their characterization in the form of environmental sub-goals. In this context, this contribution has the merit to be distinguished from the studies carried out in the same context by using the ERA approach to tally the prioritization of the EI by the allowance of environmental goals (Gareth, 1998; Diakaki *et al.*, 2006; Azom *et al.*, 2012).

In practical implications, this contribution is a beginning for the use of the EPIs in the Algerian tanneries according to their characteristics and their environmental behavior. In this context, our proposal of environmental objectives allocation on the prioritized indicators is very significant for the EPE process and, consequently, for the implementation of the environmental best practices. Nevertheless, and taking into account the current difficulties in the judicious choice of candidate indicators to complete an EPE by the Algerian tanneries, the aim of the methodology developed in this paper is, so, to suggest EI that will be candidates in an EPE process. The interest of the proposed methodology is that these indicators represent the different categories of EI set by the ISO 14031 standard and also reply more or less with the criteria of representatively, operability and decision support.

As a conclusion, the proposed approach provides to the EPE process a reduced set of useful indicators for its best deployment in Algerian tanneries.

Glossary

EPE environmental performance evaluation
ERA environmental risk assessment
EPI environmental performance indicators
EA environmental aspects
EG environmental goals

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Further reading

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