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APPLICATION OF MCDM METHODS IN EVALUATION OF ENVIRONMENTAL IMPACTS

Abstract: *The paper is focused on evaluation of environmental impacts in the Pilot organization using multiple MCDM methods. The aim of this study was to determine the objectivity and reliability of the MCDM methods for the purpose of evaluation of the significance of environmental impacts, which is considered as a key step in the implementation of ISO 14001 standard (Environmental Management System). For this purpose, multiple methods AHP, AHP Entropy, TOPSIS, VIKOR and Entropy VIKOR have been used in the paper. The results of this comparative analysis were carried out on concrete data.*

Keywords: *MCDM methods, Environmental impacts, ISO 14001 standard*

1. Introduction

ISO 14001 standard (Environmental Managements System) does not propose the way of evaluation of the environmental aspects and impacts. The standard allows the organization to create individually their methodology for environmental aspects and impacts evaluation. In fact, the standard ISO 14004 (ISO 14004:2004, 2004), requirement 4.3.1.5 indicates that “the importance is a relative concept and cannot be defined in absolute term". The previous notion permits the organization with complete freedom regarding the evaluation of the environmental aspects and impacts. Nevertheless, this approach can improve creativity inside the organization while creating the base for the data manipulation which depends on the organization’s Environmental Management System orientation.

Given the importance of evaluating the environmental impacts on the effectiveness and efficiency of the overall environmental management system, the paper explores the possibility of applying the MCDM methods for the purpose of objective and reliable evaluation of the environmental impacts.

Multi criteria Decision Making (MCDM) is also known as Multi Attribute Decision Making (MADM). MCDM methods are mathematical models used to solve complicated problems including various criteria for each aspect and choose the best aspect. There are many MCDM methods like:

- TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)
- AHP (Analytical Hierarchy Process)
- VIKOR
- Fuzzy Set Theory
- WSM (Weighted Sum Model)
- WPM (Weighted Product Model)

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- SAW(Simple Additive Weighting)

They have been used to solve problems in selection of robots, determining the appropriated bidder, choosing the best CBA player as well as in the field of tourism, manufacturing and power supply. Even the FMEA (Failure mode and effects analysis) and FTA (Fault Tree Analysis) (Catic *et al.*, 2013), the most popular risk assessment tools, can be based on fuzzy multi-criteria decision-making and used for a never-ending improvement of product quality (Fargassa, 2009). It is especially efficient when hypothesis are supported by experimental evidences (Fargasa *et al.*, 2014). In all methodologies, it is revealed that the relative importance or priority weights assigned to the considered evaluation criteria have an immense role in obtaining the accurate rankings of the material alternatives. However, it is not clear what is the effect of those criteria weights or number of criteria in the material selection decision matrix on the solution accuracy and ranking performance of the adopted MCDM methods (Chakarbortya and Chatterjeeb, 2013). Therefore, it has also been a practice to use several of them in solving one problem so as to compare results. Usually it is not easy to verify validity of results. Certainly, methods that have a software support too are most commonly used nowadays.

In the paper we made an analysis of following hypothesis:

MCDM methods are realible and objective for evaluation environmental impacts.

2. Decision making with MCDM methods

4.1. Decision making with AHP method

This paper stresses the Analytic Hierarchy Process (AHP), a well-known MCDM method of scientific analysis and decision-making by calibration of hierarchies whose elements are goals, criteria, sub-criteria and alternatives. AHP is reliable and easy to use for decision-making jobs and that is why it has been most commonly used and most popular among experts and practitioners (Altuzarra *et al.*, 2007).

AHP is multi-criteria method which is based on disaggregation of more complex problem on several levels of hierarchy with established objective on the top as the first level. The following level is criteria and sub-criteria and the final level represents alternatives. The basics of AHP hierarchy consists of three levels (objective, criteria and alternatives), but it is possible to further disaggregate this structure. This approach of disaggregation can be realized when necessary level of detail is achieved. Figure 1 (Jovanovic, 2009) represents four levels of AHP hierarchy. However, it should be considered that it could be the case that Figure 1 does not present the complete possibility. In other words, it is possible that one criterion is not in common to all alternatives (k1, A1, A2) which divides the hierarchy into the sub-hierarchy with same objectives (Figure 1).

In the AHP approach, the Objective is first defined and then criteria, sub-criteria and lastly the alternatives. Hence, the approach for defining problems is from top to bottom (UP BOTTOM). AHP allows evaluation of levels in both directions (UP BOTTOM) and (BOTTOM UP), but in the practices the evaluation from top, i.e. evaluation of criteria related to objectives, sub-criteria related to criteria, alternatives related to sub-criteria. Final result of AHP method is a list of relevant alternatives significance related to objective. The comparison in pairs is realized by Saaty scale which is presented in Table 1 (Saaty, 1989; Triantaphyllou *et al.*, 1998) which is considered as a base for AHP implementation.

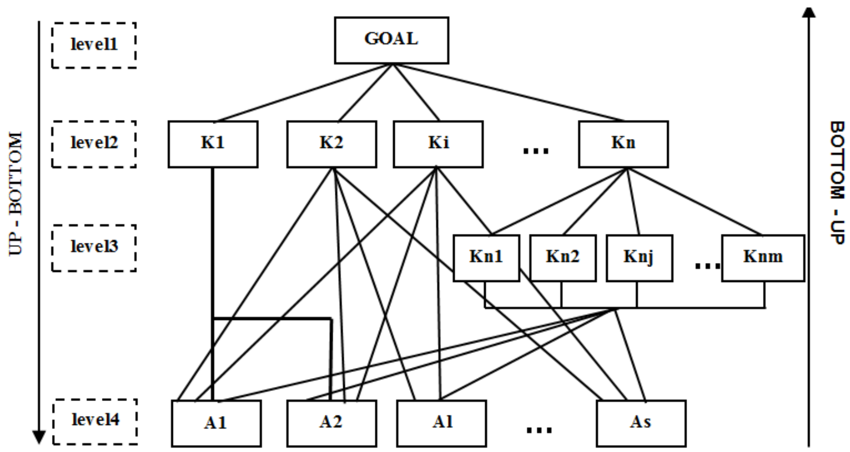


Figure 1. An example of AHP hierarchy

Table 1. Saaty scale of comparison

1	The same meaning
3	Low dominance
5	Strong dominance
7	Very strong dominance
9	Absolute dominance
2,4,6,8	Inter-values that are used for presenting balance between notes

AHP procedure itself is based on 6 basic steps (Saaty, 1994):

1. Definition of the problem and clearly set goal and possible alternatives (solutions) of the problem.
2. Decomposition of the problem into hierarchical structure with defined criteria, sub-criteria and alternatives.
3. Comparison of paired elements from the same level in relation to the element of a higher level.
4. Determination of relative weight coefficients of hierarchical elements
5. Testing of evaluation consistency.
6. Synthesis of relative weights of decision-making elements in order to get a complete evaluation of significance of alternatives (solutions).

The main advantage of AHP approach is regarding the possibility that apart from individual decision making, it allows group decision making which is used more often. Previously described procedures which are related to individual decision making represent the basics of group evaluation where we have more decision makers with fundamental differences concerning the summary of final results. Individual decision making is also very useful to derive rank lists and prioritise and has been used in [Ali *et al.*, 2012).

The hierarchical problem structure of the evaluation of environmental impacts in Pilot organization by AHP method application is realized with the environmental manager. The environmental manager coordinates evaluation of the environmental impacts by applying the AHP method but at the same time the actor in problem structuring of decision-making method is very well familiar with basic importance of all hierarchical structuring problem elements.

Three criteria that we used in the AHP model hierarchy are also signed as the most significant in ISO 14004 standards. These criteria are:

- Volume of impacts,
- Power of impacts,
- Probability of the impacts appearance.

Therefore, using this approach an AHP model has been created for evaluation of environmental impacts for all environmental medium (air, people, water and ground) as it is presented in Figure 2.

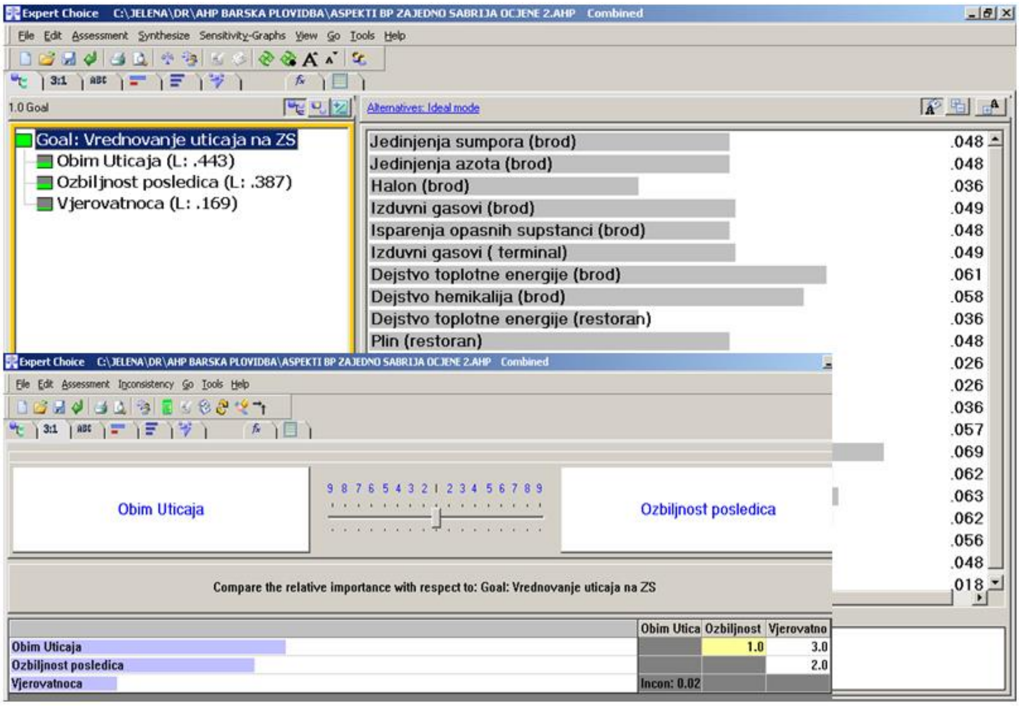


Figure 2. AHP model for evaluation of environmental impacts in Pilot organization

The evaluation performed by applying the AHP methods, represents certain improvement compared to mathematical methodologies of the ISO 14001 certified organizations. The reason for this is because there is wide spread of mathematical model for the decision making on facts whose verification is realized worldwide and not only on the local level. Evaluation of the criteria compared to the goal was performed by mutual comparison, while the evaluation of impacts compared to the criteria was performed by direct input of values from the scale from 1 to 4.

After the evaluation of all the hierarchical levels, the model provides the list of significance of the identified environmental impacts (Figure 3).

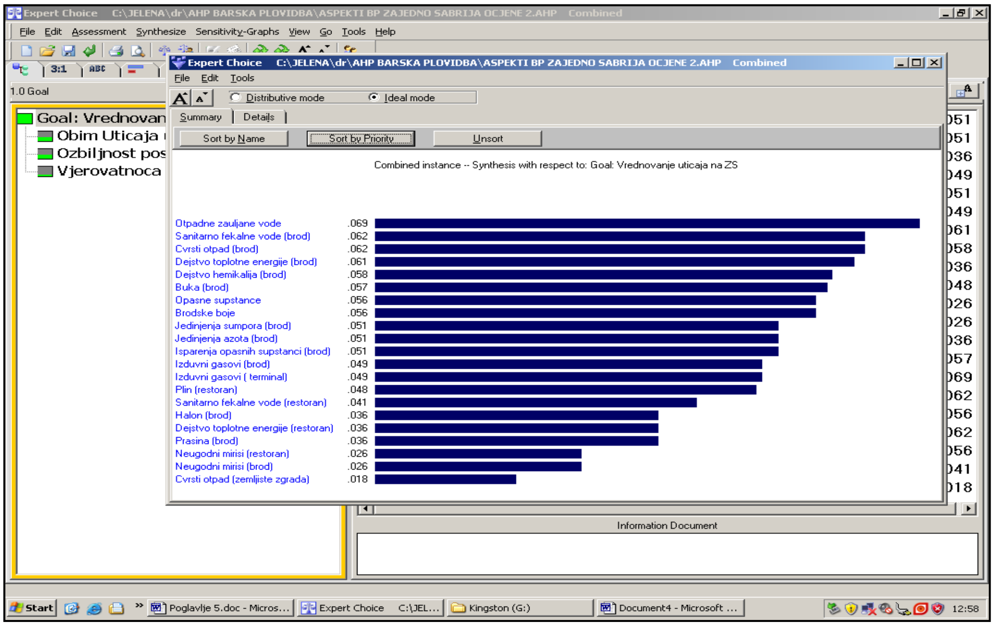


Figure 3. Rank list of the environmental impacts significance by AHP

In this way we have got rank list of all environmental impacts. With the help of the rank list of environmental impacts it is very easy to define where the border is, between significant and non-significant environmental impacts.

2.1 Decision making with TOPSIS method

The Technique for Order of Preference by Similarity to Ideal Solution is commonly know as TOPSIS. It is a popular MCDM tool which was originally developed by Hwang and Yoon (1983), further improved by Yoon in (1987) and Hwang *et al.* (1993). TOPSIS is used when the user prefer a simpler weighting technique unlike AHP (Golam & Ahsan Akhtar Hasim, 2012). It has been widely accepted method in the context of MADM (Arnoosh *et al.*, 2012).

According to this technique, the best alternative would be the one that is nearest to the positive ideal solution and farthest from the negative ideal solution (Benitez *et al.*, 2007). The positive ideal solution is a solution that maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria (Wang and Chang, 2007; Wang and Elhag. 2006; Wang and Lee, 2007; Lin *et al.*, 2008). In other words, the positive ideal solution is composed of all best values attainable of criteria, whereas the negative ideal solution consists of all worst values attainable of criteria (Ertuğrul and Karakasoğlu, 2009).

TOPSIS is usually used to prioritize alternatives through comparing them to the best and the worst solutions. Possibility of incorporating qualitative and quantitative factors is one of the benefits of this technique. Another benefit of this method is the ability of separating indicators into cost or profit categories. (Arnoosh et al., 2012)

In following few steps will be presented TOPSIS method. Let xij be the inputs for matrix of priorities where there are i 1,, m alternatives and j 1,, n criteria. There are six steps associated with the implementation of TOPSIS as follows,

Step 1. Construct normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} \sum_{j=1}^{n} x_{ij}^2}} \quad (1)$$

Step 2. Construct the weight normalized matrix

$$v_{ij} = w_i r_{ij}, i = 1, \dots, m \quad j = 1, \dots, n \quad (2)$$

Step 3. Determine the positive and negative ideal solutions

$$A^+ = \{v_1^+, \dots, v_n^+\} \text{ where } v_j^+ = \{\max(v_{ij}) \text{ if } j \in J;\ \min(v_{ij}) \text{ if } j \in J'\}$$
$$A^- = \{v_1^-, \dots, v_n^-\} \text{ where } v_j^- = \{\min(v_{ij}) \text{ if } j \in J;\ \max(v_{ij}) \text{ if } j \in J'\} \quad (3)$$

Step 4. Calculate separation (positive and negative) measures for each alternative

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_j^+ - v_{ij})^2},\ S_i^- = \sqrt{\sum_{j=1}^{n} (v_j^- - v_{ij})^2},\ i=1,\dots,m \quad (4)$$

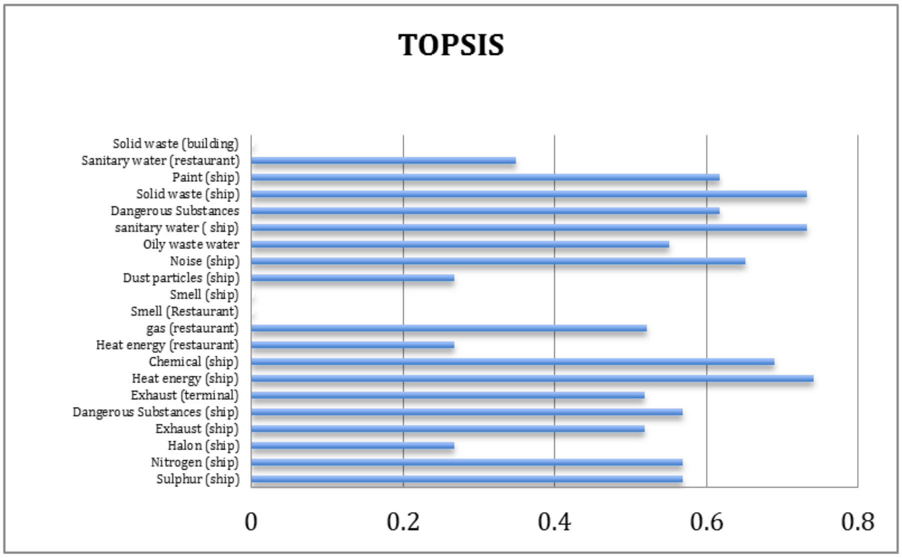
Step 5. Calculate the relative closeness to the ideal solution

$$C_i^+ = \frac{S_i^-}{S_i^- + S_i^+},\ 0<C_i^+<1,\ i=1,\dots,m \quad (5)$$

TOPSIS is a viable method for the proposed problem and is suitable for the use of precise performance ratings (Golam & Ahsan Akhtar Hasim, 2012). Thomaidis *et al.* (2008) implemented TOPSIS for the wholesale natural gas market prospects in the energy community treaty countries. TOPSIS has been also used in internet services, for instance, Cheng *et al.* (2011) used TOPSIS for Web service selection problems (Cheng *et al.*, 2011). It has been used in many information technology applications of science and engineering (Chang *et al.*, 2010).

Even, we used software package Expert Choice for application AHP method, we used Excel for application all other MCDM methods. Excel is commonly used to make calculations and create charts where the latter makes the analysis easier.

Results of evaluation environmental impacts using TOPSIS method is presented at the figure 4.



Sulphur (ship)	0.568282963	Dust particles (ship)	0.267237816
Nitrogen (ship)	0.568282963	Noise (ship)	0.651348541
Halon (ship)	0.267237816	Oily waste water	0.550583603
Exhaust (ship)	0.517991459	sanitary water (ship)	0.732762184
Dangerous Substances (ship)	0.568282963	Dangerous Substances	0.617386215
Exhaust (terminal)	0.517991459	Solid waste (ship)	0.732762184
Heat energy (ship)	0.741754841	Paint (ship)	0.617386215
Chemical (ship)	0.690203023	Sanitary water (restaurant)	0.348651459
Heat energy (restaurant)	0.267237816	Solid waste (building)	0
gas (restaurant)	0.520719083	Smell (ship)	0
Smell (Restaurant)	0		

Figure 4. Results of application TOPSIS method

As we can see on figure 4, the most important impacts are: sanitary water (ship), heat energy and solid waste (ship) which is similar as results obtained in application of AHP method. Discussion of results is presented in the last chapter after application of all MCDM methods.

2.2 Decision making with VIKOR method

VIKOR means multi-criteria optimization and compromise solution (Ebrahimnejada et al., 2012). Opricovic (1998) introduced VIKOR method. This MCDM method is comprehensive and simple (Chakrabortya and Chatterjeeb, 2013). The ranking performance of VIKOR method is superior to that of TOPSIS and PROMETHEE methods (Chakrabortya and Chatterjeeb, 2013). VIKOR method is mainly based on the particular measure of closeness to the ideal solution and it focuses on selecting the best choice from a set of feasible alternatives in presence of mutually conflicting criteria by determining a compromise solution (Chakrabortya and Chatterjeeb, 2013). VIKOR method uses linear normalization and the normalized value does not depend on the evaluation unit of a criterion (Chakrabortya and Chatterjeeb, 2013). VIKOR method integrates maximum group utility and minimal individual regret simultaneously (Chakrabortya and Chatterjeeb, 2013).

It is also revealed that among the three considered MCDM methods, VIKOR outperforms the others due to its undeniable advantages (Chakrabortya and Chatterjeeb, 2013).

There are typical applications of VIKOR method in the various industrial fields like evaluation of software development projects (Büyük Zkan and Ruan, 2008), partners' choice in IS/IT outsourcing projects (Chen and Wang, 2009), project risk identification and prioritization (Tavakkoli-Moghaddam, 2011a), and plant location selection (Tavakkoli-Moghaddam, 2011b).

Results of evaluation environmental impacts using Vikor method is presented in figure 4.

Sulphur (ship)	0.70526996	Smell (ship)	0.150737697
Nitrogen (ship)	0.70526996	Dust particles (ship)	0.367574867
Halon (ship)	0.367574867	Noise (ship)	0.765029508
Exhaust (ship)	0.495757328	Oily waste water	1
Dangerous Substances (ship)	0.70526996	sanitary water (ship)	0.837611569

Exhaust (terminal)	0.495757328	Dangerous Substances	0.726127884
Heat energy (ship)	0.803572648	Solid waste (ship)	0.837611569
Chemical (ship)	0.773692874	Paint (ship)	0.726127884
Heat energy (restaurant)	0.367574867	Sanitary water (restaurant)	0.464294859
gas (restaurant)	0.64780398	Solid waste (building)	0
Smell (Restaurant)	0.150737697		

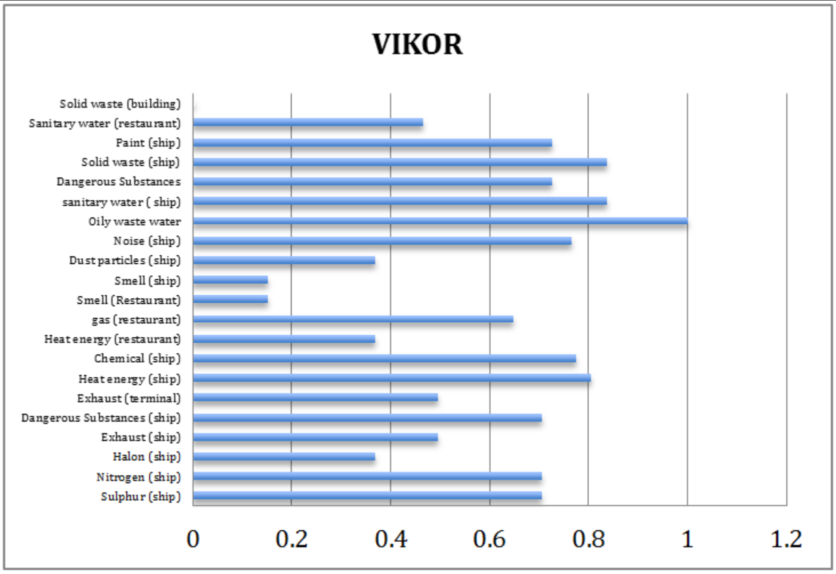


Figure 5. Results of application TOPSIS method

As we can see in figure 5, the Oily waste water is the most important environmental impact in application of VIKOR method. All other environmental impacts have smaller significance then the first one.

Recently, VIKOR has been widely applied for dealing with MCDM problems of various fields, such as location selection (Tzeng *et al.*, 2002a), environmental policy [Tzeng *et al.*, 2002b) and data envelopment analysis (Tzeng and Opricovic, 2002).

Reza Raei *et al.* (2012) conclude that VIKOR gives better results than TOPSIS.

3. Entropy method in MCDM methods

Entropy weighting is a method which is made up of the monitoring values of evaluation index in objective conditions, can determine the target and the degree of order and effectiveness by referring to evaluation of information entropy (Bing and Denghao, 2001). It avoids the subjectivity of the weights of various criteria, and therefore the results of evaluation can be better able to reflect the actual situation (Bing and Denghao, 2001).

Shannon introduced the information entropy theory, which is based on the thermodynamic principle where entropy is the degree of disorder of the molecules in a substance for the first time. It has been applied as a measure of disorder, unevenness of distribution, the degree of dependency or complexity of a system (Zhaohong and Wei, 2012).

The establishment of weight:

1) Assuming that there are m evaluation objects, each object being evaluated in n criteria, a comparison matrix,

$$R = (r_{ij})_{m\times n} \quad (i=1,2,...,m; j=1,2,...,n)$$

is constructed.

2) Using the proportion of i-index value objects below j-criteria, another matrix,

$$P_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}} \quad (j=1,2,...,n)$$

is constructed.

3) According to the concept of entropy, m-evaluation things and n-evaluation criteria are used to calculate the entropy,

$$H_j = \frac{-\sum_{i=1}^{m} P_{ij}\ln P_{ij}}{\ln m} \quad (j=1,2,...,n)$$

In order to make lnPij meaningful, Pij=0, PijlnPij=0 is assumed.

4) The Entropy weight is calculated using

$$W_j = \frac{1-H_j}{n-\sum_{j=1}^{n} H_i} \quad (i=1,2,...,m)$$

5) Establishment of Rank for criteria.

This is achieved by using Entropy weights in MCDM methods. The Entropy theory has been used in (Xiaoliang *et al.*, 2010; Xie *et al.*, 2012; Xiangxin *et al.*, 2011; Jiliang *et al.*, 2011; Silviu, 1986; Zhaohong and Wei, 2012). Papers (Bing and Denghao, 2001; Zhaohong and Weim, 2012) and Xiangxin *et al.* (2011) stress that using entropy the effect of subjective factors is reduced, leading to objective results.

3.1 Decision Making with AHP- Entropy method

AHP is a subjecting weighting method, putting together qualitative and quantitative analysis where criteria weights are assumed based on experience and intuition leading to deviations (Xie *et al.*, 2012).

The rank list is found out by using the entropy weights in the final step of AHP:

$$A_i = \sum_{j=1}^{n} (W_j \times R_j) \quad (i=1,2,...,m)$$

Based on the combined evaluation method, paper (Xie *et al.*, 2012)] evaluates the safety of smart grid by using the AHP-entropy method which combines the subjective weights and objective weights. This method is simple, practical and accurate. In paper (Xie *et al.*, 2012) they analyzed four regions for proving that the evaluation results correspond with the actual situation in various regions.

Therefore, we solve the same problem by taking weights from entropy method and use them in the final step of AHP to determine the ranks.

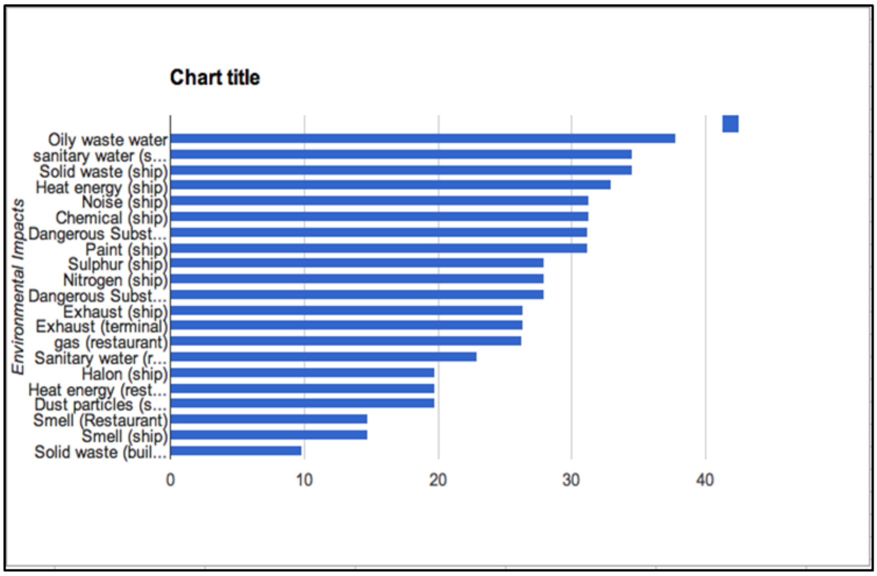
Even, we used software package Expert Choice for application AHP method, we used Excel for application AHP Entropy method. Excel is commonly used to make calculations and create charts where the latter makes the analysis easier. The comparison matrix was, therefore used in Excel along with the formulae to achieve the expected results.

	Volume of Impact	Power of Impact	Probability of Impact Appearance
Hi	1.55387463655637	1.6525520312425	1.67073211433622
	-0.553874636556374	-0.652552031242502	-0.670732114336225
	4.8771587821351	3.32328414557873	1.67073211433622
W	0.295060088591116	2.01850922838897	-0.504587616664862

Figure 6. Entropy and Entropy weights

We can see from figure 6 that in Entropy method Hi for Volume of Impact, Power of Impact and Probability of Impact Appearance was found to be 1.55, 1.65 and 1.67 respectively. Entropy weights W were calculated as 0.29, 2.01 and -0.50 respectively. It is very important to mention that these data are clearly differ from the Saaty scale weights (–0.443, 0.387 and 0.169 for each criteria respectively) in AHP method. Reason for that is difference between methods of evaluation for these two methods.

Rank list of the environmental impacts significance by AHP Entropy method is presented in figure 7.



Oily water waste	37.81	Exhaust (ship)	26.4
Sanitary water (ship)	34.49	Exhaust (terminal)	26.4
Solid waste (ship)	34.49	Gas (restaurant)	26.27
Heat energy (ship)	32.93	Sanitary water (restaurant)	22.94
Noise (ship)	31.28	Halon (ship)	19.74
Chemical (ship)	31.26	Heat energy (restaurant)	19.74
Dangerous Substances	31.14	Dust particles (ship)	19.74
Paint (ship)	31.14	Smell (restaurant)	14.74
Sulphur (ship)	27.94	Smell (ship)	14.74
Nitrogen (ship)	27.94	Solid waste (building)	9.87
Dangerous Substances (ship)	27.94		

Figure 7. Rank list of the environmental impacts significance by AHP Entropy method

The ranking appears to be the same in both methods – AHP (figure 2) and AHP Entropy (figure 7) except that the ranks of Chemical (ship) and Noise (ship) are interchanged. In AHP Entropy, Noise (ship) is ranked as fourth whereas Chemical (ship) is fifth unlike AHP.

This difference occurs because in AHP entropy, the weights are used in the last step of AHP from Entropy to reduce the subjectivity unlike AHP where they were based on the Saaty scale.
Similar procedure is performed with TOPSIS and VIKOR method with aim to obtain results of evaluation environmental impacts using TOPSIS-Entropy and VIKOR-Entropy method.

4. Analysis results of evaluation environmental impacts using all the above methods

After application of all most frequently used MCDM methods we performed the comparative analysis of obtained results. In table 1 are presented results of evaluation environmental impacts using AHP, VIKOR and TOPSIS method as well as their Entropy methods.

Table 1. Comparative analysis of MCDM methods for evaluation of environmental impacts

	AHP	Entropy AHP	VIKOR	Entropy VIKOR	TOPSIS	Entropy TOPSIS
Sulphur (ship)	9	9	9	9	8	6
Nitrogen (ship)	9	9	9	9	8	6
Halon (ship)	16	16	16	12	16	15
Exhaust (ship)	12	12	13	6	13	12
Dangerous Substances (ship)	9	9	9	9	8	6
Exhaust (terminal)	12	12	13	6	13	12
Heat energy (ship)	4	4	4	2	1	2
Chemical (ship)	5	6	5	6	4	1
Heat energy (restaurant)	16	16	16	12	16	15
gas (restaurant)	14	14	12	17	12	5
Smell (Restaurant)	19	19	19	19	19	19
Smell (ship)	19	19	19	19	19	19
Dust particles (ship)	16	16	16	12	16	15
Noise (ship)	6	5	6	2	5	11
Oily waste water	1	1	1	1	11	18
sanitary water (ship)	2	2	2	2	2	9
Dangerous Substances	7	7	7	15	6	3

Solid waste (ship)	2	2	2	2	2	9
Paint (ship)	7	7	7	15	6	3
Sanitary water (restaurant)	15	15	15	18	15	14
Solid waste (building)	21	21	21	21	19	19
Spearmans rank correlation coefficient	0.998650906	1	0.994597241	0.827389016	0.912102001	0.58989614

Results of application MCDM methods for evaluation of environmental impacts in form of diagram is presented in figure 8.

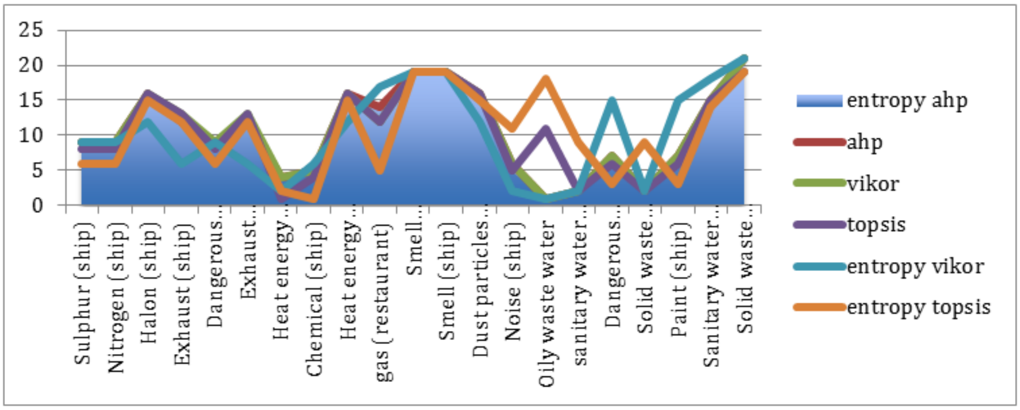


Figure 8. Comparative analysis of application of MCDM methods

Analyzing Figures 7 and 8, we observe that rankings of the impact on the environment obtained by applying the method AHP, AHP Entropy and Vikor methods are very similar. In addition, we observe great deviations in comparison with Vikor Entropy, TOPSIS and Topsis Entropy methods. However, results obtained by applying Vikor Entropy method are much closer to the results obtained by applying AHP, AHP Entropy and VIKOR method then TOPSIS and Topsis Entropy methods.

In paper (Fragassa, 2010), the same data were used to verify the results obtained by applying AHP method of models based on neural networks. Thus we obtained results compatible with results provided by AHP model. In addition, by analyzing all impacts on environment, it was confirmed that results provided by AHP method are realistic and correspond to the situation in the organization observed.

As 3 of 6 methods have given results that are confirmed by models based on neural networks in the paper (Fragassa, 2010), the hypothesis that MCDM methods are realible and objective for evaluation environmental impacts can be confirmed. In addition, having in mind that the results of all applicable MCDM methods are not entirely in compliance with each other, confirms the fact that in solving some problem where we can precisely determine the accuracy of final result it is necessary to use several MCDM methods because there is no absolutely the best MCDM method in solving particular issue.

5. Conclusions

Methodology for evaluation of environmental impacts isn't explicitly defined in standard ISO 14001 or standard ISO 14004, but analyzing the different accesses of the ISO 14001 certified organizations, we conclude that, in this area, there are a lot of possibilities of data manipulation. Therefore, this paper presents the accesses of the evaluation of environmental impacts in application of MCDM methods

The environmental impacts from a pilot organization were evaluated using MCDM methods – AHP, AHP Entropy, Vikor, Vikor Entropy, Topsis and Topsis Entropy method. It is found that methods AHP, AHP Entropy and Vikor are useful for ranking environmental impacts, especially while making individual decisions and finding out the most significant ones, so accordingly changes can be made in the company and the impacts can be improved upon. Even AHP Entropy appears to be more reliable than AHP since its weights, being from Entropy weighting method makes the rank lists more objective, both methods give very similar results. Vikor method also gives similar results as AHP and AHP Entropy methods.

However, 3 of 6 methods have given almost identical results that are confirmed by models based on neural networks in the paper (Jovanovic *et al.*, 2013). According that, in this work we confirm hypotheses that "application of MCDM methods are reliable and objective for evaluation environmental impacts" which removes possibilities of manipulation. This point is one of the most important requirements of ISO 14001 (4.3.1 Environmental aspects).

In addition, having in mind that results of all applied MCDM methods are not in complete harmony, once again the fact that in solving some issue where we cannot precisely determine the accuracy of final result, it is required to use several MCDM methods because there is no absolutely the best MCDM method in solving particular problem is confirmed.

The special attention for the future research work should be oriented on determining objectiveness and reliability of application of only AHP and AHP Entropy method in evaluation of impacts on environment in order to avoid the application of a greater number of MCDM methods for these purposes.

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