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SIGNIFICANCE EVALUATION OF ENVIRONMENTAL ASPECTS

The identification of environmental aspects is an essential premise for implementation of EMS in a production company, but not a sufficient one. In order to effectively reduce negative environmental impacts, first it is necessary to undertake a thorough examination of given environmental aspects. For this purpose, several methods can be used. In this article, 3 such methods are described in detail, namely the method of Total pair comparison, the Rank method and the Saaty method. A properly prepared classification of all involved environmental aspects, evaluated by their importance can be considered a first step for successful environmental pollution reduction or elimination. In order to determine and quantify which environmental aspects have the highest priority, the Pareto analysis and Lorenz curve method can be used.

1. Introduction

To establish a functional and successful environmental system in a company, the first key step is to identify all aspects with potentially negative impact on the environment, including a significance analysis, with the goal to determine which aspects are the most harmful for the environment. The most harmful aspects are then called significant environmental aspects. These aspects can be controlled directly, modifying the main production process, or indirectly through supporting processes, such as the distribution, packaging, transport, design, etc. The approach the company takes to manage their environmental system, depends on company's economic situation, market share and competition ability. Those companies that inflict significant impacts on environment are required to create a system for better identification, monitoring and evaluation of significant environmental aspects.

2. Environmental aspects identification and monitoring

It is important to mention that environmental aspects identification does not require meticulous investigation of product life cycle, only the production processes. Aspects that were identified as important, must be monitored, managed and analyzed, to prevent, or at least minimize the scope of potential environmental damage. For this reason it is important to systematically and continually measure and monitor significant environment damaging aspects during EMS implementation. To identify environmental aspects, it is important to focus on:

- Specific significance of each environmental aspect, considering the state legislation and environmental norms requirements,
- The frequency of performed activities, or provided services, frequency of goods and services purchase related to identified environmental aspects,
- The probability of environmental aspect occurrences,
- Significance and potential impact of given environmental aspect.

In the example below, a given company identified 7 groups of environmental aspects (Table 1). To determine their influence on environment, following three methods were applied, namely:

- The method of total pair comparison,
- The rank number method,
- Analytic Hierarchy Process – AHP method also called Saaty method[3].

The above mentioned methods indicate the sequence rank number of the most significant aspects, which deserve more attention. Electro energy consumption causes depletion of available natural resources and at the same time represents high production costs. Excessive electro energy consumption is caused mainly by high performance engines of wood processing facilities. As the wood processing industry relies heavily on high performance machines with considerable electro energy consumption, the old obsolete wood processing facilities should be gradually replaced by new energy efficient models.

Alternatively, the company might consider investing into electro energy generators based on ecological systems and clean ecological technologies. Water energy can be used to produce electricity in small water energy power plants. Water energy belongs among renewable energy sources. For renewable energy projects the most considerable cost item is the initial investment. After the company paid for the renewable energy technology, the most significant factor affecting the product price are operational costs. These however are relatively low for renewable energy technologies.

Overall evaluation H_i of each aspect can be calculated by multiplication of all values for given row, expressed as $H_i = \prod_i a_{ij}$.

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Comparing aspect groups utilizing method of total pair comparison

Table 1

Aspect groups											
1	2		3		4		5		6		7
Sawdust	Electro energy consump-tion	Electro energy consump-tion	Wood	Wood	Bark	Bark	Cutting discs attrition	Cutting discs attrition	Tools attrition	Tools attrition	Chemicals consump-tion
Sawdust	Wood	Electro energy consump-tion	Bark	Wood	Bark	Bark	Tools attrition	Cutting discs attrition	Chemicals consump-tion		
Sawdust	Bark	Electro energy consump-tion	Cutting discs attrition	Wood	Bark	Bark	Chemicals consump-tion				
Sawdust	Cutting discs attrition	Electro energy consump-tion	Tools attrition	Wood	Chemicals consump-tion						
Sawdust	Tools attrition	Electro energy consump-tion	Chemicals consump-tion								
Sawdust	Chemicals consump-tion										

Environmental aspect identification

Table 2

Aspect group	Impact	Evaluation	Significance [%]	Weight w_i
Sawdust	Waste production	1	5%	0.05
Electro energy consumption	Natural resources consumption	4	19%	0.19
Wood	Natural resources consumption	3	14%	0.14
Bark	Pollution production	0	0%	0.00
Cutting discs attrition	Pollution production	6	28%	0.28
Tools attrition	Pollution production	5	24%	0.24
Chemicals consumption	Dangerous waste production	2	10%	0.10
Total		21	100 %	1.00

Saaty matrix

Table 3

	Sawdust	Electro energy con-sumption	Wood	Bark	Cutting discs attrition	Tools attrition	Chemicals consumptio n	H_i	R_i	Weights w_i
Sawdust	1	1/7	1/6	1/2	1/5	1/9	1/3	0.000	0.263	0.030
Electro energy consumption	7	1	2	1/3	4	5	5	466.667	2.406	0.272
Wood	6	1/2	1	1/4	3	1/2	1/3	0.375	0.869	0.098
Bark	2	3	4	1	1/6	1/5	1/3	0.267	0.828	0.094
Cutting discs attrition	5	1/4	1/3	6	1	1/7	3	1.071	1.010	0.114
Tools attrition	9	1/5	2	5	7	1	7	882.000	2.635	0.298
Chemicals consumption	3	1/5	3	3	1/3	1/7	1	0.257	0.824	0.093
									8.835	1.000

From that we get $R_i = H_i^{1/n}$ (or $\left(\prod_i a_{ij}\right)^{\frac{1}{n}}$). Sum on all R_i, expressed as $\sum_i R_i = R$ serves for weight calculation $w_i = \frac{R_i}{R}$.

The weights are then used to determine the rank for each environmental aspect.

The rank numbers and weights calculated using different methods are shown in Table 4. The final rank numbers of all monitored environmental aspects are based on their weight values. After displaying the rank numbers using polygons chart (Fig. 1), different position numbers of individual environmental aspects indicate their significance. In this specific example, the most significant difference can be observed for chemicals consumption, which indicates that further inquiry for this environmental aspect is needed. In cases like this the Spearman's rank correlation coefficient can be used.

$$R = 1 - \frac{6 \cdot \sum d_i^2}{n \cdot (n^2 - 1)},$$

where:

d_i – is the difference in environmental aspect rank number for each used methods,

$n = 7$ is the number of identified and evaluated environmental aspects.

The results of the correlation methods are shown in Table 5. It is apparent that between the method of total pair comparison and the Saaty method there is a strong correlation $R = 0.79$. Between the method of total pair comparison and the rank method, the relation is insignificant. It is also advisable to calculate "average" of all three methods as indicated by correlation coefficients for each method and the "average" ($R = 0.82; 0.75; 0.89$).

After retrieving "representative" rank numbers based on significance of individual environmental aspect, it is apparent that the first 3 environmental aspects in the overall evaluation show a 63% influence. As shown in Pareto analysis and Lorenz curve results (Fig. 2), these 3 environmental aspects are the ones where the attention should be focused first. [1]

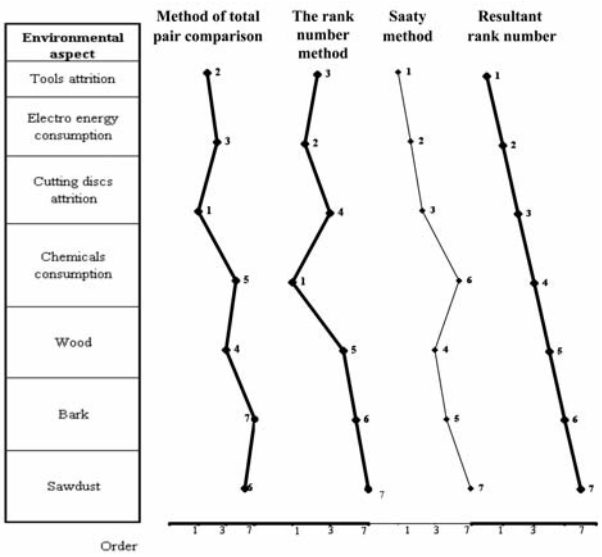

Fig. 1 Polygons of environmental aspect rank number for all applied methods

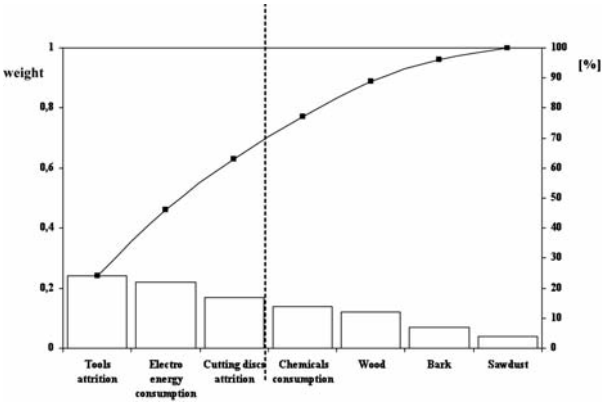

Fig. 2 Pareto analysis and Lorenz curve of environmental aspect evaluation

Evaluation of environmental aspects significance — Table 4

Method						Environmental aspect			Final sequence
Of total pair comparison		The rank number		Saaty					
R.n.	weight	R.n.	weight	R.n.	weight		R.n.	weight	
1	0.28	4	0.12	3	0.19	Cutting discs attrition	2.7	0.20	3
2	0.24	3	0.19	1	0.30	Tools attrition	2.0	0.24	1
3	0.19	2	0.19	2	0.27	Electro energy consumption	2.3	0.22	2
4	0.14	5	0.11	4	0.10	Wood	4.3	0.12	5
5	0.10	1	0.23	6	0.09	Chemicals consumption	4.0	0.14	4
6	0.05	7	0.05	7	0.03	Sawdust	6.7	0.04	7
7	0.00	6	0.11	5	0.09	Bark	6.0	0.07	6
	1.00		1.00		1.00			1.00	

Second power of rank numbers subtract for each two methods Table 5

	d_i^2-					
Environmental aspect	TPC /RN	TPC/SAAT	RN/SAAT	TPC/AVE	RN/AVE	SAAT/AVE
Cutting discs attrition	9	4	1	4	1	0
Tools attrition	1	1	4	1	4	0
Electro energy consumption	1	1	0	1	0	0
Wood	1	0	1	1	0	1
Chemicals consumption	16	1	25	1	9	4
Sawdust	1	1	0	1	0	0
Bark	1	4	1	1	0	1
Σd_i^2	30	12	32	10	14	6
R	0.46	**0.79**	0.43	**0.82**	**0.75**	**0.89**

3. Conclusion

Regular and long-term monitoring of environmental aspects can help providing a proper company evaluation, in regard to adhering to state environmental legislation and fulfilling legislation limit for given country. Such monitoring also indicates the areas of environmental protection where the company must dedicate more effort and more financial investment.

A sudden change in one of the environmental aspects might indicate an incident in company operation. This information is vital for the management, for company's employees as well as for other organizations, especially considering social and civic responsibilities of the company. The implementation of new environmental and renewable sources technologies, can provide an increased yield of natural resources and might reduce the risk of negative impacts on environment. Therefore, such technologies are of increasing importance, especially to companies with positive attitude towards environmental and social issues. The recent increase in the number of projects focused on electrical energy production from renewable sources shows the importance and support of this research within the European Union.

Acknowledgements

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