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USING THE EXPERT ASSESSMENTS TO DETERMINE THE IMPORTANCE OF QUALITY AND EFFICIENCY INDICATORS OF ENVIRONMENTAL MANAGEMENT

The process of using the expert assessments to determine the importance of quality and effectiveness of environmental management is researched in this article. The expert determination is given. Using the coefficient of concordance is established that there is a certain order in relation to the indicators of importance of the effectiveness of environmental management in the results of the examination. It has been determined the degree of each expert's influence to the generalized groups co-ordination. The degree of co-ordination has been determined

Keywords: environmental management, quality of environmental management, efficiency of environmental management, coefficient of concordance, expertise, resource consumption.

Лозовська Н.М. ВИКОРИСТАННЯ ЕКСПЕРТНИХ ОЦІНОК ДЛЯ ВИЗНАЧЕННЯ ВАЖЛИВОСТІ ПОКАЗНИКІВ ЯКОСТІ ТА ЕФЕКТИВНОСТІ ЕКОЛОГІЧНОГО МЕНЕДЖМЕНТУ

У статті здійснено дослідження процесу використання експертних оцінок для визначення важливості показників якості та ефективності екологічного менеджменту. Наведено визначення експерта. З допомогою коефіцієнта конкордації встановлено, що в результатах експертизи є певний порядок стосовно показників важливості ефективності екологічного менеджменту. Визначено, в якій мірі кожний експерт впливає на узагальнену узгодженість групи. Визначено ступінь узгодженості думок експертів.

Ключові слова: екологічний менеджмент, якість екологічного менеджменту, ефективність екологічного менеджменту, коефіцієнт конкордації, експертиза, ресурсоемність.

Лозовская Н.Н. ИСПОЛЬЗОВАНИЕ ЭКСПЕРТНЫХ ОЦЕНОК ДЛЯ ОПРЕДЕЛЕНИЯ ВАЖНОСТИ ПОКАЗАТЕЛЕЙ КАЧЕСТВА И ЭФФЕКТИВНОСТИ ЭКОЛОГИЧЕСКОГО МЕНЕДЖМЕНТА

В статье проведено исследование процесса использования экспертных оценок для определения важности показателей качества и эффективности экологического менеджмента. Приведено определения эксперта. С помощью коэффициента конкордации установлено, что в результатах экспертизы есть определенный порядок относительно показателей важности эффективности экологического менеджмента. Определено, в какой мере каждый эксперт влияет на обобщенную согласованность группы. Определена степень согласованности мнений экспертов.

Ключевые слова: экологический менеджмент, качество экологического менеджмента, эффективность экологического менеджмента, коэффициент конкордации, экспертиза, ресурсоемность.

Statement of the problem. Indicators of quality and efficiency of environmental management are the basis for determining the efficiency of the environmental management system's functioning. It is necessary to carry out the examination to determine the importance of indicators of quality and efficiency of environmental management that gives you the opportunity to specify a particular order in the relative importance of performance indicators for environmental management.

Analysis of recent researches and publications. Issues of environmental management at the enterprises in the current economic conditions has been researched by such domestic and foreign scientists as S.E. Derjaguina, V.A. Astafyeva, N.N. Strukova, L.V. Strukov, V.G. Potapenko, V.V. Karmanov, G.S. Arzamasova, B.C. Karmanova and other.

The selection of unsolved the problem. Taking note of the urgency of environmental problems in modern enterprises, the problem of defining the importance of indicators of quality and efficiency of environmental management appears.

The purpose of the article. To propose a methodology of research the process of the using the expert assessments to determine the significance of indicators of quality and efficiency of environmental management.

The main material. To account for the significance of each of the indicators in the quality and effectiveness of environmental management need to carry out the examination. In this case you need to refer to the opinion of experts. An expert is a competent specialist on a particular issue, whose estimates and judgments about the examination object are taken into account when you make a decision. The predicted expert assessment reflects the individual views of experts about the

prospects for the development of the object and bases on the mobilization of professional experience and intuition. Under the expertise we understand the measurement of certain characteristics of an object before making a decision.

Examination of the importance of indicators for environmental management is carried out in the following stages:

1. Statement of the examination purpose is the determining the role of each indicator in the scorecard assessment of the effectiveness of environmental management;
2. The construction of examination objects or their characteristics – the system of indicators of the 6 main characteristics of the effectiveness of environmental management in dynamics of 2009–2013 on the totality of the studied companies.
3. Establishment of an expert group (see tab. 1).
4. Definition of expert assessment and presentation of expert examinations – questionnaires.
5. Carrying out the examination is the distribution and organization of feedback with the experts who live in different cities.
6. Processing and analysis of examination results.
7. Re-examination, if there is a need to clarify or convergence of experts' opinions in the expert survey this stage is not applied because a highly professional group of experts provided assessments that have a high degree of consistency. And gradual process of experts' elimination with the calculation of the consistency of opinions for remained experts, allowed to determine the range of experts with an original point of view, which differs from total. If necessary, you can conduct a further survey for the installation of explanations for these differences.

8. The formation of variants of the recommendations is based on the highest summarizing assessment of indicators of environmental management.

The analysis of competence in the present study should be carried out with the help of special questionnaires. In the answers the candidates have demonstrated their business and professional qualities, as well as analytical skills. To determine whether a potential expert meets the demands the questionnaire was used. Experts in determining the importance of performance indicators for environmental management were environmentalists and senior managers of the food industry. Experts in determining the importance of quality indicators for environmental management have been the teacher of ecology, biology, engineer, medical officers, specialist sanitary-epidemiological station, forestry workers and veterinarian. Additionally, the assessment of the competence of the expert was proposed. Each expert determined the measure of his knowledge on the subject, in other words he had made a self-assessment on a 10-point scale. The value of score for self-assessment: 0 – the expert does not understand the issue; 1, 2, 3 – expert versed in the issue little, but it belongs to the circle of his interests; 4, 5, 6 – expert versed in the issue satisfactorily, but he is not directly involved in the practical solution it; 7, 8, 9 – expert versed well in the issue, he is involved in practical decision; 10 – issues belong to the circle of narrow specialization of the expert.

It is established that in the given results there is a certain order in the relative importance of indicators for environmental management (tab. 1) and there is an ability to determine their actual ratings. This is evidenced by the sum of squared deviations and the coefficient of concordance, which allowed us to assess the degree of consistency in the opinions of experts (m – number of experts; n – number of signs).

$$d_i^2 = \sum_{i=1}^n S_i^2 - \frac{(\sum S_i)^2}{n}; d_i^2 = 8920 - (210)^2/6 = 1570,$$

$$w = \frac{12 \cdot d_i^2}{m^2(n^3 - n)}; w = \frac{12 \cdot 1570}{10^2(6^3 - 6)} = 0,8971;$$

Since the value corresponds to the significance level that is within (0,0053; 0,015), the hypothesis of inconsistent opinions of experts reject with probability of error that does not exceed 0.015. Concordance factor takes values from 0 to 1. The higher the value of coefficient of concordance, the higher the degree of consistency of expert opinions. When $w=1$ there is consistency of experts opinions; if $w=0$, the consistency is almost absent.

Statistical significance of the coefficient of concordance has been tested by Pearson criterion χ_p^2 .

$$\chi_p^2 = \frac{12d_i^2}{m \times n(n-1)},$$

$$\chi_p^2 = \frac{12 \times 1570}{10 \times 6(6-1)} = 62,8.$$

The calculated value of χ_p^2 , is compared with the table value ($m-1$) degrees of freedom and a confidence level ($P=0,95$ or $P=0,99$). If $\chi_p^2 > \chi_{table}^2$, the coefficient of concordance is significant, if $\chi_p^2 > \chi_{table}^2$, it is necessary to increase the number of experts. For the survey at 10-1 degrees of freedom and $P=0,95$ $\chi_{table}^2=3,325$, and for $P=0,99$ $\chi_{table}^2=2,088$. And in both cases, $\chi_p^2 > \chi_{table}^2$, therefore, the coefficient of concordance is statistically significant.

We can finally arrange the indicators of environmental management on their importance according to the sums of the numbers. So, the indicator “of the amount of used water per manufactured products” takes the first place, “the volume of emissions (carbon dioxide), which falls per unit of manufactured products”, the second place, “the carrying capacity of an enterprise” – the third place, “pollutant emissions in kilograms per unit of output” the fourth place, “pollutant emissions in the current year as a percentage of the emissions in the base year” – the fifth; “total amount of waste and the dynamics of their compliance with the limits” – the sixth place.

When assessing the consistency of experts' opinions it is important to determine the degree of each expert affects generic consistency group. For this one expert consistently excludes from the calculation and the coefficient of concordance calculates without consideration of the views of the excluded expert (see tab. 2).

Therefore, the exclusion of the second, ninth and tenth of experts has a positive effect on the consistency of experts' opinions. On the contrary, alternately off 1st, 3rd, 4th, 5th, 6th, 7th, 8th experts reduce the overall coherence of the entire group. And equally reduces the coherence of the views exclude 3rd, 4th, 6th, 7th experts to 0,8899.

The exception of the 1st, 5th and 8th experts reduce equally the coherence to 0,8956. An exception from the aggregate of the individual experts that having an original point of view must be done with great care. In the process of multistage expertise we can see the possible cases when such experts will attract to their side a significant part of the group.

The range of experts' opinions which essentially reflects the consistency of the views assessed, except

Table 1
The results of the survey regarding to the importance of performance indicators environmental management

	Index	Expert's number									
		1	2	3	4	5	6	7	8	9	10
	Self-assessment	7	10	10	10	10	10	10	10	10	10
1	The carrying capacity of an enterprise	19	21	18	17	18	15	17	17	14	13
2	Emissions into the atmosphere (carbon dioxide) per unit of product produced	15	14	19	18	19	23	21	16	15	14
3	Number of used water per unit of output	34	33	29	33	34	35	36	37	31	30
4	Pollutant emissions in kilograms per unit of output	14	13	15	13	13	12	12	14	17	17
5	Emissions pollutants in the current year relatively to the percentage of the emissions in the base year	10	8	11	10	6	8	8	9	5	8
6	Total amount of waste and the dynamics of their compliance with the limits	8	11	8	9	10	7	6	7	8	8
	The total score	100	100	100	100	100	100	100	100	100	100

Grouped by the author according to the results of a survey of experts

Table 2

Assessment of the consistency of survey results on the importance of performance indicators environmental management system indicators variation

Indicator	rating (scales for multivariate mean)	variance mean	square (standard) deviation	Coefficient of variation
The carrying capacity of an enterprise	16,9000	5,6556	2,3781	0,1407
Emissions into the atmosphere (carbon dioxide), which falls per unit of manufactured products	17,7000	8,0111	2,8304	0,1599
The number of used water falls on unit made products	34,2000	5,5111	2,3476	0,0686
Emissions of polluting substances in kilograms, that are unit made products	14,2000	4,8444	2,2010	0,1550
Emissions of pollutants in the current year as a percentage of the emissions in the base year	8,6000	2,9333	1,7127	0,1992
Total amount of waste and the dynamics of their compliance with the limits	8,4000	2,2667	1,5055	0,1792

for the coefficient of concordance, with the help of other statistical indicators, including (see tab. 2)

The system of indicators reflects the degree of consistency of opinion in general (coefficient of concordance) and in separate directions. Basically, for individual indicators, such estimates are consistent. But the greatest degree observed in terms of “the amount of water used per manufactured products” (the coefficient of variation 0,0686 or 6,86%) and “the carrying capacity of an enterprise” (the coefficient of variation 0,1407 or 14,07%). The most variable of the experts’ assessments relate to the indicator “Total amount of waste and the dynamics of their compliance with the limits” (the coefficient of variation 0,1792 or 17,92%) and the indicator “Emissions of pollutants in the current year as a percentage of the emissions in the base year” (the coefficient of variation 0,1992 or 19,92%).

Conclusions. The main advantages of these methods are the maximum utilization of individual experts’ abilities and minor psychological pressure on the individual performer. However, these methods are almost not suitable to predict the most common strategies because of limited knowledge of one expert specialist on the development of related fields of science. To avoid (or reduce the impact) of such a defect we can use the col-

lective methods of expert estimations. The essence of collective expert assessment for the development of the projections is in the definition of agreed expert opinion on perspective directions of development of object of forecasting, previously formulated by individuals, and the evaluation of trends in the development of object that cannot be determined using other methods (e.g., analytical calculation, experiment, etc).

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