IMPLEMENTATION OF PROCEDURES FOR DELIMITING ENVIRONMENTAL COSTS FOR EFFCIENT MANAGEMENT FOLLOWING THE EXAMPLE OF THE ELECTRICAL LIGHTING EQUIPMENT INDUSTRY

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Abstract: *In the current stage of development and improvement of technologies used in the field of electrical lighting equipment, but especially in the production of LED lighting systems, the innovative technology used in the production process has a very important place, because, for now, it represents a very efficient method, being able to achieve high quality products and various sizes and models. The legislative and environmental particularities and also the technological particularities specific to this field of activity, subject to special regulations different from the other industries are presented. The case study focused on presenting the importance of calculating costs in the electrical lighting equipment industry through certain activities involving environmental costs caused by the placing on the market of electrical and electronic equipment (EEE). In this sense, we aimed to analyze environmental management accounting (EMA) from a theoretical perspective, systematization of EMA, its evolution and its implementation factors, but also the analysis of mathematical methods, with which we will develop an empirical study, allowing us to quantify the impact of environmental costs caused by the placing on the market of electrical and electronic lighting equipment. Unlike previous empirical studies that examine only mature market economies, our study examines the effect of environmental performance, measured by analyzing the environmental costs of putting on market the electrical and electronic lighting equipment, which helps us make the decision to implement advanced technologies in order to properly size production, on the financial performance of the transition economy. This study focuses on determining the main products in the field of Airfield lighting, over a management period, which influences the variation of environmental costs. Empirical studies show various results on the relationship between environmental management and company performance.*

Keywords:. *electrical lighting equipment industry; managerial accounting; model matematic; costuri de average*

JEL Classification: M40, M31, G21

Literature review

In order to be able to provide a business perspective within the various organizations in the business environment regardless of their field of activity, data forecasting is one of the biggest challenges, involving at the same time the uncertainty, accuracy and error of this data. In order to be able to highlight and predict the evolution of data, we need to know certain techniques for predicting them.

With the help of prediction, risks and opportunities can be identified. In this sense,

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various reliable methods have been developed to a certain extent. Prediction models must be validated and updated for their results. There are various techniques: (Seltam, 2014):

- for data prediction and forecasting: least squares method or maximum probability method, etc. (Subramaniam, et al, 2017);
- Artificial intelligence (AI) and assisted learning are an advanced version of the tools needed to predict data. These methods use multilayer architectures to find the nature of the data from the lowest to the highest level, and this structured data is used to predict a huge amount of data (Moustris et al, 2012), the error is introduced into the model since the prediction stage and during data processing it must be kept to a minimum;
- Optimization models in economic mathematics (Mohajan, 2017): The Lagrange multiplier method is a technique in multivariable computation, and was used to more easily determine economic conditions, being considered as a device for transferring a constraint problem to an unrestricted problem of higher dimensions (Moolio et al. 2009, Islam et al. 2010, 2011). Baxley and Moorhouse (1984) considered that functions are not given explicitly, but characterize a perspective on economic behavior, and will later explain these characteristics (Baxley and Moorhouse 1984, Mohajan 2012), for example if in the case of an organization the reduction to minimum of the production costs of a product, it is possible to know how the changes in the purchase prices will influence ??, so the problem is not "find the minimum", but "assuming that the minimum is obtained, what consequences can be deduced" - the situation.

In line with increasingly stringent environmental regulations, industrial costs for environmental protection have had a dynamic trend over the past 40 years (Gerasimova, L .; Silka, 2019; Gray, 2010; Jasch, 2003).

Government regulations allow the EMA to be explored or revised for issues related to: financial reporting regulations, national statistics reporting regulations or environmental reporting regulations, and planning rules; Environmental Management System (EMS) regulations, business licensing requirements. Voluntary adoption of standards and self-regulation of EMA involves collaboration with: various users / stakeholders of EMA, accounting associations, ISO / EMAS, GRI, bankers, insurance companies and other members of financial services, to study the potential for adoption / inclusion of the EMA guidelines or requirements in these activities.

In practice, the level of implementation of the EMA is quite low due to the existing gaps in the academic environment regarding the knowledge of the EMA and its potential to identify inefficiencies in a production process and for the comparative analysis of environmental costs that would result from superior environmental and economic performances (Christ et al, 2007; Ván,, 2012; Ferreira et al. 2010; Schaltegger et al., 2010; Burritt et al., 2009).

The implementation of solutions for organic production, through investments in ecological technology in order to adjust or modify production processes and products can contribute to the reduction or significant elimination of total environmental costs per entity (Căpușneanu et al, 2017), but also to productivity increases the adopting entity. Also, the implementation of practical solutions for determining the dependency relationship between a certain type of waste and the categories of manufactured products is of particular importance for the implementation of a sustainable management system at the level of economic entities to identify those product categories that generate higher volumes of waste.

Calculation methodology and data

2021						
Domain	**Product**	**Product**	**Period**	**No. of**	**Collection,**	**Value**

	range	**type**		**products (pieces)**	**treatment, processing, EEE disposal fee**	
Beacon lighting	Pulsar	Low intensity	January	47	0,3	14,1
			February	63	0,3	18,9
			March	51	0,88	44,88
			April	114	0,88	100,32
			May	69	0,88	60,72
			June	127	0,88	111,76
			TOTAL	**471**		**350,68**
	Quasar	Average intensity	January	0	0,3	0
			February	5	0,3	1,5
			March	6	0,88	5,28
			April	16	0,88	14,08
			May	18	0,88	15,84
			June	21	0,88	18,48
			TOTAL	**66**		**55,18**

Quantities of electrical equipment placed on the market following the related production process within an entity that produces electrical lighting equipment, in the Aerfild field:

- Beacon lighting (table no.1):

Table no.1 Volume of production and environmental expenditure placed on the market (EEE)

Period / domain type: beacon	**Physical volume of production (pieces)**	**Environmental costs related to the marketing of EEE**
January	47	14,10
February	68	20,40
March	57	50,16
April	130	114,40
May	87	76,56
June	148	130,24
TOTAL	**532**	**405,76**

== 1,3234 pcs Q_t

Source: own projection

We calculate the environmental costs related to the production that was obtained and placed on the market (EEE) according to (table no. 1).

The least squares procedure

It involves completing the following work steps:

- Calculation of total variable environmental costs and fixed environmental costs for each management period t;
- Determination of variable, fixed and total environmental expenditures for January of the following financial year.

= = 67,626 lei

The determination of the deviation of the physical volume of production in each period from its average volume, the deviation of the environmental expenses in each period from their average, the product of the two deviations, as well as the determination of the square mean deviation of the production volume, are performed in (table no. 2):

Table no. 2 Deviation of the physical volume of production from the analyzed management period.

Period	**Deviation of production volume (lei)**	**Deviation of environmental costs (lei)**	**The product of deviations (lei)**	**Deviation of production squared (lei)**
January	-46	53	2461,92	2116
February	-67	47,22	3163,74	4489
March	-56	17,46	977,76	3136
April	-129	-46,78	6034,62	16.641
May	-86	-8,94	768,84	7396
June	-147	-62,62	9205,14	21.609
TOTAL	**0**	**0**	**22.612,02**	**55.387**

Source: own projection

- Calculation of unit deviation:
= =0,41 lei/ piece

a) Calculation of total variable environmental costs and fixed environmental costs for each management period t, (table no.3):

Table no. 3 Calculation of variable and fixed environmental costs.

Period	**Variable environmental costs (lei)**	**Fixed environmental costs (lei)**
January	19,27	-5,17
February	27,88	-7,48
March	23,37	26,79
April	53,30	61,10
May	35,67	40,89
June	60,68	69,56
TOTAL	**220,17**	**185,69**

Source: own projection

We calculate the environmental costs related to the production obtained and placed on the market (EEE) according to (table no. 3).

It involves completing the following work steps:

- Calculation of total variable environmental costs and fixed environmental costs for each management period t;
- Determination of variable, fixed and total environmental expenditures for January of the following financial year.

= = 67,626 lei

The determination of the deviation of the physical volume of production in each period from its average volume, the deviation of the environmental expenses in each period from their average, the product of the two deviations, as well as the determination of the square mean deviation of the production volume, are performed in (table no. 4):

Table no. 4 Deviation of the physical volume of production from the analyzed management period.

Period	Deviation of production volume (lei)	Deviation of environmental costs (lei)	The product of deviations (lei)	Deviation of production squared (lei)
January	-46	53	2461,92	2116
February	-67	47,22	3163,74	4489
March	-56	17,46	977,76	3136
April	-129	-46,78	6034,62	16.641
May	-86	-8,94	768,84	7396
June	-147	-62,62	9205,14	21.609
TOTAL	**0**	**0**	**22.612,02**	**55.387**

Source: own projection

-- Calculation of unit deviation:

= =0,41 lei/ piece

a) Calculation of total variable environmental costs and fixed environmental costs for each management period t, (table no.5):

Tabel nr.5 Calculul cheltuielilor de average variabile și fixe

Period	Variable environmental costs (lei)	Fixed environmental costs (lei)
January	19,27	-5,17
February	27,88	-7,48
March	23,37	26,79
April	53,30	61,10
May	35,67	40,89
June	60,68	69,56
TOTAL	**220,17**	**185,69**

Source: own projection

Based on the data from any two management periods according to the proposed example and taking into account the two months of the financial year, we obtain for six months:

Multiplying the first equation by -1, it results:

-53,68=/-60 b b = 0,89 lei

We replace the value obtained in each equation 130,24= a +148 x 0,89 a=130,24 -131,72 = -1,48 lei.

So:

$CV_{u\ environment}$ = 0,89 lei/ piece

$CF_{u\ environment}$ = -1,48 lei/ piece

Determination of variable average expenses for each management period, distinguishing between total environmental and fixed environmental expenses for each period:

$CV_{m\ January}$= 14,10lei - -1,48 lei = 15,58 lei

$CV_{m\ February}$ = 20,40 lei - -1,48 lei = 21,88 lei

$CV_{m\ March}$ = 50,16 lei - -1,48 lei = 51,64 lei

$CV_{m\ April}$ = 114,40 lei - -1,48 lei = 115,88 lei
$CV_{m\ May}$ = 70,56 lei - -1,48 lei = 78,04 lei
$CV_{m\ June}$ = 130,24 lei - -1,48 lei = 131,72 lei

The procedure based on marginal cost

According to this procedure, the determination of variable environment costs from fixed environment costs is based on the rule that for the same production capacity put on the market by the producer, an increase in production income only leads to an increase in variable environment costs.

By tracking the number of products placed on the market at marginal cost, the total of the environment variable costs in a given management period is obtained.

$CV_{t\ environment} = Q_t \times Cm_{environment}$

where: $Cm_{environment}$ – marginal environmental cost, calculated by relation:

$Cm_{environment}$ = = in which:

$Ch_{environment\ n}$, $Ch_{environment\ n-1}$= total environmental expenses in two consecutive management periods;

Q_{n0}, Q_{n-1} = the volume of production placed on the market in two consecutive management periods.

By subtracting the variable environmental expenses from each management period from the total related ones, the fixed environmental expenses for each period we obtain:

$CF_{t\ environment} = Ch_{t\ environment} – CV_{t\ environment}$

For example, the next three months of the period analyzed in the financial year for the six months, n, the situation is presented in (table no.6):

Table no.6 Total fixed environmental expenses for three months of the analyzed period n.

Period	Physical volume of marketed production (pieces)	EEE environmental expenses (lei)	Marginal environmental cost (lei / pc.)	Variable environmental costs (lei)	Fixed environmental costs (lei)
0	1	2	3	4=1x3	5=2-4
April	130	114,40		114,40	0
May	87	76,56		76,56	0
June	148	130,24		130,24	0

Source: own projection

The separation of environmental expenses into fixed and variable can also be done starting from the residual cost which is calculated as the difference between the unit cost (environment) and the marginal cost of environment.

$Cv_{environment} = Cu_{environment} - Cm_{environment}$

The unit environmental cost is calculated by relating the total costs of each management period to the volume of production of electrical lighting equipment placed on the market in that month:

$Cu_{environment} = Cp_{environment} / Q_t$

By multiplying the volume of production of electrical lighting equipment placed on the market by the residual cost, fixed costs are obtained.:

$CF_{t\ environment} = Q_t \times Cr_{environment}$

Variable expenses are calculated by making the difference between total and fixed expenses:

$CV_{t\ environment} = Ct_{environment} - CF_{environment}$

Based on the data from the previous proposed application, the situation is as follows (table no.7):

Table no. 7 Separation of variable and fixed environment costs according to residual cost.

Period	**Fixed production volume EEE (pcs)**	**Environmental costs (lei)**	**Marginal environmental cost (lei)**	**Environmental unit cost EEE (lei/ pc.)**	**Average residual cost (lei/ pc.)**	**Fixed environmental costs (lei)**	**Variable environmental costs (lei)**
0	1	2	3	4=2/1	5=4-3	6=1x5	7=2-6
April	130	114,40	-1,48	0,88	2,36	306,80	-192,40
May	87	76,56	-1,48	0,88	2,36	205,32	-28,76
June	148	130,24	-1,48	0,88	2,36	349,28	-219,04

Source: own projection

Results

The results explicitly present some mathematical models, emphasizing the economic and statistical significance. The mathematical model includes the environmental costs caused by the placing on the market of electrical lighting equipment (EEE) as a dependent variable and the number of products made as an independent variable. Indirectly, in calculating the environmental costs related to the products of electrical and electronic equipment placed on the market, their price is used according to the legislative regulations in force for each type of product. The results obtained from the implementation of mathematical calculation methods allow us to highlight the fact that the economic entity's concerns to introduce new technologies to produce electrical lighting equipment can lead to a reduction in environmental costs related to marketing (EEE), but also to a reduction of the environmental expenditures on all categories of expenditures.

Conclusions

Following the empirical study conducted in the company producing electrical lighting equipment we quantified the impact of production on environmental costs generated by electrical lighting equipment placed on the market during the period January-June 2021. The results of the study show to what extent the production of electrical appliances and the manufacturing technology specific to the economic entity producing electrical lighting equipment influences the environmental costs of placing them on the market at the time of sale.

The research conclusions are presented following the implementation of mathematical methods for identifying environmental costs depending on the weight of electrical lighting equipment placed on the market and the cost of placing it on the market according to the legislative regulations in force, depending on their weight. The results obtained from the implementation of mathematical methods for calculating environmental costs allow us to make some essential remarks necessary to improve the efficient management of environmental costs. The impact of production on environmental costs caused by the placing on the market of electrical lighting equipment between January and June 2021 are not relevant enough. From the point of view of reporting the entire production for the analyzed period to the cost of placing them on the market, there is an average of 1.3234 pieces. The mathematical model summarized by table 3.4, shows a unit deviation of 0.41 lei / piece. Following the calculation of the variable, fixed and total expenses for January of the following year, a unitary variable environmental expense in the amount of 1.14 lei / piece resulted. Considering the total production for the analyzed period, the average value procedure indicates a variable average unit cost of 1.14 lei / piece, identical to their forecast for the first month of the previous year. The unit cost of EEE environment calculated for the three months of the analyzed period, according to table no.3.7. is 0.88 lei, and the average residual cost, according to the same source, is 2.38 lei, economically significant. For an increase of 100 pieces of production, environmental expenses, increase on average by 0.03 lei. Considering the annual production of the studied economic entity the result is significant, however the analysis of the presented data suggests an approach at on product groups or on each product.

It is up to the user to implement the econometric model, the essential criterion being the financial contribution on reducing environmental costs caused by aluminum waste.

The conceptual approaches of environmental management accounting (EMA), environmental accounting (EA) and environmental reporting (ER), but also the interconnections with the other notions come to fill some gaps in managerial accounting. One limitation considered is the small number of data included in the study. This limit can be eliminated by extending the sample by the entities producing electrical lighting equipment in Romania. A future research direction is the analysis of the possibilities of implementing integrated and digitized methods specific to environmental managerial accounting in order to maximize performance in the electrical lighting equipment industry.

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